Vol. 54 No. 3 January 1961

Quarterly

of the

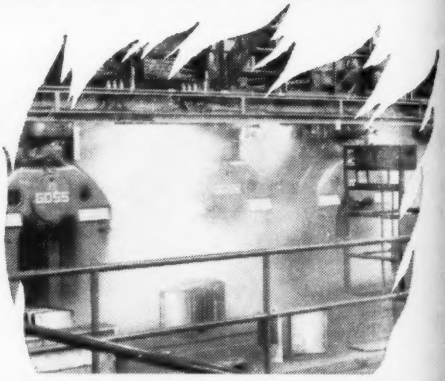
National Fire Protection Association

INTERNATIONAL

Promoting the Science and Improving the Methods of Fire Prevention and Protection Since 1896

protection

against printing plant "hot spots"



presses • reel rooms
ink mist fitters
stereo remelt pots • ink mix and storage rooms • electrical equipment

CARDOX®

CARBON DIOXIDE FIRE EXTINGUISHING SYSTEMS*

HIGH AND LOW PRESSURE from

50 lbs. to 125 TONS

3 Different Operation Proved Methods of Application— Singly Or in Combination— Deliver Any Quantity to Protect Any Number of "Hot Spots"

*Covered by U.S. and Foreign Patents and pending applications

ENGINEERED FOR MAXIMUM PROTECTION AT MINIMUM COST

WRITE TODAY for this new booklet which describes how Cardox carbon dioxide can bring "hot spot" protection to your printing plant or ask for a survey of your plant by a Cardox Engineer.

CARDOX DIVISION OF CHEMETRON CORPORATION
840 N. Michigan Avenue, Chicago 11, Illinois
Offices in principal cities

CHEMETRON

CARDOX® **PRODUCTS:** Carbon Dioxide Fire Extinguishing Systems, Trucks, and Foam Fire Equipment
Liquid Carbon Dioxide . . . Carbonic Gas . . . Dry Ice.

ment

py

atents.
ng
ns.

COST

dioxide
urvey of

quipment

Vol. 54 No. 3 January 1961

Quarterly

The Standard Technical Journal of Fire Protection for More Than Fifty Years

The NFPA is a nonprofit technical and educational organization devoted to the reduction of loss of life and property by fire with a total membership of nearly 18,000. The QUARTERLY is one of the publications regularly provided to members. Other membership publications include *Fire News*, *Advance Reports* to the Annual Meeting, a *Year Book*, and many leaflets, pamphlets, and posters issued throughout the year on fire prevention and control. Seven volumes of the National Fire Codes are available on an annual subscription basis, one volume free and others at reduced membership rates. For full details on available material ask for a free list of "Publications on Fire Prevention and Protection."

NFPA annual dues are $15.00 for Associate Membership of which $6.00 is for subscription to this Journal. National and regional societies or associations may apply for an organization membership for which annual dues are $100; such a membership entitles four individuals to receive the periodical membership publications.

Technical committees of the Association develop means to safeguard life and property through the publication of standards covering all phases of fire prevention and protection. Your membership in the Association affords an opportunity to keep abreast of these developments, and, by being a member, you help support this humanitarian activity. Popular educational literature on fire safety is constantly being produced by the NFPA for distribution through its members to the general public.

National Fire Protection Association

International

60 Batterymarch Street **Boston 10, Mass., U.S.A.**

Entered as second-class matter December 15, 1928, at the Post Office at Boston, Mass., under act of March 3, 1879

Printed in U.S.A.

National Fire Protection Association

International

Officers

LOREN S. BUSH, *President*, Chief Engineer, Pacific Fire Rating Bureau, Public Protection Engineering Department

J. SHARP QUEENER, *Vice-President*, Manager, Safety & Fire Protection Division, E. I. du Pont de Nemours & Co.

WARREN J. BAKER, *Vice-President*, Manager, Technical Department, Insurance Company of North America

HOVEY T. FREEMAN, *Secretary-Treasurer*, President and Treasurer, Manufacturers Mutual Fire Insurance Co.

Board of Directors

The Officers and

T. SEDDON DUKE, *Chairman*, President, Star Sprinkler Corporation

JOHN A. NEALE, *Past President*, Summit, New Jersey

HENRY G. THOMAS, *Past President*, Hartford, Conn.

W. H. BERRY, Vice-President, America Fore Insurance Group

A. SIDNEY BRIGGS, Manager, Fire Prevention and Engineering Bureau of Texas

J. R. DEHAVEN, Vice-President, Employers Mutual Fire Insurance Co.

FRANK J. FEE, JR., President, Reliable Automatic Sprinkler Co.

R. H. FERGUSON, Asst. Director, Industrial Relations, Republic Steel Corp.

W. H. FORRISTALL, General Manager, Factory Insurance Association

PAUL C. LAMB, Safety Administrator, Lever Brothers Company

JEROME LEDERER, Managing Director, Flight Safety Foundation

ELMER O. MATTOCKS, Director, Department of Technical Services, American Petroleum Institute

WILLIAM L. MILLER, Chief Engineer, Department of Fire, City of Los Angeles

JOHN H. REDMOND, Vice-President and Manager of Operations, Tar Products Division, Koppers Company, Inc.

CARROLL E. SHAW, Deputy State Fire Marshal of Connecticut

GEORGE F. WAHL, General Manager, Factory Mutual Engineering Division

W. M. WETZEL, Chairman of the Board, The Fyr-Fyter Company

E. C. WOOD, President, Imperial Tobacco Company of Canada, Ltd.

Staff

PERCY BUGBEE, *General Manager*

CHESTER I. BABCOCK, *Manager, Fire Record Department, Chemist*

HORATIO BOND, *Chief Engineer*

MARGUERITE C. CHAFFIN, *Editorial Assistant*

PHYLLIS L. DEPLOEY, *Assistant to Technical Secretary*

BEATRICE L. FINLEY, *Office Supervisor*

RENÉE FOSSE, *Editorial Assistant*

HENRY S. GERE, *Advertising Manager*

CLARK F. JONES, *Gases Field Service*

WARREN Y. KIMBALL, *Manager, Fire Service Department, Managing Editor, Firemen*

PAUL R. LYONS, *Assistant Manager, Fire Service Department, Editor, Firemen*

BARBARA L. MACKAY, *Librarian*

GORDON P. MCKINNON, *Editorial Coordinator*

CHARLES S. MORGAN, *Assistant General Manager*

ROBERT S. MOULTON, *Technical Secretary*

DEUEL RICHARDSON, *Manager, Public Relations Department*

DORIS A. SHELDON, *Supervisor, Publications Service Department*

FRANK STETKA, *Electrical Field Service*

RICHARD E. STEVENS, *Assistant Technical Secretary*

THEODORE TORREY, JR., *Fire Record Department*

GEORGE H. TRYON, III, *Assistant Technical Secretary*

AGNES W. WILSON, *Supervisor, Bookkeeping Department*

REXFORD WILSON, *Fire Record Department*

MILES E. WOODWORTH, *Flammable Liquids Field Service*

Quarterly

of the

NATIONAL FIRE PROTECTION ASSOCIATION

Copyright 1961, National Fire Protection Association

ROBERT S. MOULTON, *Managing Editor*
GEORGE H. TRYON, III, *Editor*
CHESTER I. BABCOCK, *Associate Editor*
MARGUERITE C. CHAFFIN, *Editorial Assistant*
RENÉE FOSSE, *Editorial Assistant*
HENRY S. GERE, *Advertising Manager*

Vol. 54 No. 3 **JANUARY, 1961**

Table of Contents

Fatal San Francisco Hotel Fire ..... Frontispiece

Fire Protection Developments in 1960
Percy Bugbee, General Manager, NFPA 211

Moving Forward in Fire Protection
Loren S. Bush, President, NFPA 215

Aircraft Crash-Fire-Worthiness
George H. Tryon, Assistant Technical Secretary, NFPA 219

LP-Gas Tank Truck Fire at Fort Devens
Clark F. Jones, NFPA Gases Field Service 227

Large Loss of Life Fires of 1960
An NFPA Fire Record Department Study
Introduction 233
In Residential Properties 235
In Transportation Equipment 251
In Industrial Properties 263
In Mercantile Properties 265
Other Fatal Fires 268

Acetylene Transmission Systems 269

Index to Advertisers 278

Articles and accounts of fires appearing in the Quarterly are based on material forwarded to the Association. The Association, as a body, does not assume responsibility for the accuracy of the material printed herein.

This publication is indexed by Engineering Index, Inc.

Wide World

Twenty of the 135 occupants of the Thomas Hotel in San Francisco lost their lives and another 35 were injured during an early morning fire on January 6, 1961. Originating in the first-floor room of an intoxicated man who fell asleep while smoking, the fire extended to upper stories of the 5-story building by means of an open stairway. There was a 10- to 15-minute delay in fire department notification as the hotel clerk and a guest first tried to put out the bed fire with an extinguisher. Flames were issuing from windows on all floors when apparatus arrived.

The local Housing Code required enclosure of stairways in hotels but compliance by the 48-year-old Thomas Hotel could not be obtained since the building had been built prior to 1947, when the Code was adopted. A detailed report of the fire is published in the February 1961 *Fire News*.

Fire Protection Developments in 1960

By Percy Bugbee, General Manager,

National Fire Protection Association

The preliminary estimate of the 1960 fire loss in the United States stands at $1,541,000,000. Of this total, $1,145,000,000 represents damage to buildings and contents. The remaining $396,000,000 is loss in non-building fires such as aircraft, ship fires, motor vehicle fires, and forest fires. The over-all loss is slightly higher than the corresponding figure for 1959 which was $1,439,640,000.

NFPA estimate of loss of life from fires in 1960 in the United States is 11,350. This is a very slight increase over the estimate for 1959.

By far the most serious fire in the United States during the past year occurred on December 19 in the huge unfinished aircraft carrier *U.S.S. Constellation* at the Brooklyn Navy Yard.* This fire cost the lives of 50 workmen. The victims were trapped below decks when fire broke out following a spill of diesel fuel on the hangar deck. Preliminary estimates of the property damage to the *Constellation* are set at $47,942,000. There are only two or three fires in the U. S. that have ever exceeded this figure.

Other major U. S. loss of life fires in 1960 of wide interest were the fire at the Toledo Airport on October 29 in a plane crash in which 22 died,** a coal mine fire in Logan, W. Va., on March 8 which cost the lives of 18 miners,** and a helicopter fire at Maywood, Ill. on July 28 which caused 13 deaths.** The largest loss of life from fire during the year occurred in a hospital at Guatemala City, July 14 killing 170 persons.† On November 13, at Amude, Syria, 163 children perished in a movie house when a flash fire broke out in a pile of nitrate film beside a projection machine. Only 50 of the approximately 500 children watching the movie escaped unharmed. Another important fire of international interest, costing both lives and heavy property values, was in a whisky warehouse in Glasgow, Scotland, last March 28†. This fire cost the lives of 19 fire fighters and caused property damage of around $10,000,000

Other fires involving heavy damage in the United States in 1960 included the fire at Walker Air Force Base in New Mexico on February 3 which caused property damage estimated at $21,000,000.** In this fire a tanker plane crashed and burned, involving two other similar parked planes and a hangar. Nine persons lost their lives. A crash fire at an air force base in Puerto Rico on February 1 killed seven and caused a loss of $11,000,000.** An $8,000,000 loss was suffered in a multiple-tenant manufacturing building in Clifton, N. J. on February 17. This fire involved a completely sprinklered building, but the sprinklers were shut off prematurely by employees when they believed the fire was out.

*This fire was reported in the January 1961 *Fire News*.

**Reported in this issue of the QUARTERLY.

†Reported in detail in the October 1960 QUARTERLY of the NFPA.

Residential Fire Deaths

A detailed study of 53 fires involving loss of life of six or more persons during 1959, published in the July 1960 QUARTERLY, aroused great interest among students of fire fatalities. These fires caused 441 deaths of which 239 were in ordinary dwellings. By far the greatest number of these fires occur in small dwellings, usually from a flagrant disregard of the elementary principles of fire safety. A similar study for 1960 is included in this issue.

These tragic occurrences emphasize the continued great and pressing need for more public education, particularly in the schools, in the principles of life safety from fire. They also emphasize the great importance of the dwelling inspection program now being undertaken by more and more fire departments throughout the country. Great progress was evident throughout 1960 in the adoption by fire departments everywhere of the home inspection program. The fire chiefs of many of our cities, large and small, are to be heartily commended for undertaking this valuable extra service.

School Fire Safety

The widespread public interest in improved fire safety in school properties which was developed in 1959, following the disastrous Chicago school fire late in 1958, continued throughout the past year. Early in 1960, NFPA sponsored a national Conference on School Fire Safety in New York. The Safety to Life Committee of NFPA developed a new section of the Building Exits Code covering educational occupancies which was adopted at the annual meeting in Montreal.

During the summer the Los Angeles Fire Department conducted a second series of tests on a large school building to supplement the effective work done by that department in 1959. The results of the second series of tests will be made available early in 1961.

Fire Department Problems

As the trend of population to the suburban areas continues, more and more fire departments are being created. Present NFPA figures indicate that there are now 20,163 fire departments in the United States and 2,275 in Canada. The great majority of these departments are fully volunteer and the great public service that these volunteers render should be very widely appreciated.

In our larger cities, with fully paid fire departments, the practice continues to provide better pay and shorter hours for the paid firemen. With this trend and the squeeze that our municipalities are feeling because of the ever-increasing share of the tax dollar which is being absorbed by federal and state governments, the acute manpower shortages in fire departments is evident and is very serious. Studies made by NFPA indicate that in all too many cases apparatus is responding to fires with too few men to carry on fully effective rescue and fire-fighting services. On the plus side, with the development of two-way and three-way radio communications, fire-fighting procedures and fire inspection procedures have steadily improved.

Nearly all of our larger fire departments today have come to recognize that preventing fires is just as important a function of the fire department as putting fires out. Municipal codes for fire prevention are being widely adopted and there are better mutual aid arrangements between fire departments in the metropolitan areas.

Firemen's training programs continue to be popular. In addition to the training programs conducted by nearly every

important city, there are 36 state-wide programs in which all of the firemen in the state may participate. A considerable number of new training facilities, both in cities and in states, were developed in 1960.

Airports a Concern

In a more specialized field, but one of great concern to our cities, is the very serious fire hazard problem at our airports. Serious loss of life and property destruction continues to occur in and near airports. A step forward during the year was the adoption by the Federal Aviation Agency of the NFPA Suggestions for Aircraft Rescue and Fire Fighting Services for Airports and Heliports. Other important projects in this field pioneered by NFPA this past year included the development of tentative Specifications for Aircraft Rescue and Fire Fighting Vehicles, a Standard on Fueling Aircraft on the Ground, a Manual on the Fire Hazard Properties of Aviation Fuels, a Tentative Standard on Airport Ramp Drainage, and a revision of the Standard on Aircraft Hangars.

NFPA Standards Activity

A number of states adopted important NFPA standards during the year, including Delaware, New Mexico, Oregon, Tennessee and Wyoming. In the year 1960 there were many important new standards and revisions of existing standards adopted. Among those of very wide general use were the standards on Automatic Sprinklers, Fire Hose, Recommended Fire Protection Practice for Nuclear Reactors, Protection of Records, Cutting and Welding Equipment, Fire Department Equipment, Liquefied Petroleum Gas, and Marinas and Boat Yards.

Important progress was made during the year in the development of a system for the identification of the fire hazards of materials and a Tentative Standard was published for comment and criticism by all interested. The idea is to develop a clear and easily understood system for marking containers so that fire fighters can readily identify the fire and health hazards of the materials which they are called upon to handle under fire conditions. We believe this work will prove to be a great contribution to the safety of firemen.

NFPA is now publishing its National Fire Codes annually. The 1960–1961 National Fire Codes which appeared during the fall required seven large volumes, including 181 standards and running to 5614 pages.

Special Publications

A special study published by NFPA in 1960 of widespread interest was an analysis of 100,000 fires in which automatic sprinklers operated. This study showed satisfactory performance in 96.2 per cent of the fires.

Other publications of general interest issued in 1960 by NFPA were a new edition of the manual "Operating Fire Department Pumpers," a new book entitled "Radiation Control for Fire and Other Emergency Forces," a Table of the Fire Hazard Properties of Flammable Liquids, Gases and Volatile Solids, and a Flash Point Index of Trade Name Liquids covering some 4500 names.

Growth in Fire Protection

It is gratifying to be able to say that continued strides are being made in general public education in the field of fire prevention. Nearly all parents will recognize this because their children tell them about the lessons they are learning in school in the principles of fire safety. Nowadays thousands of children are enrolled as junior fire marshals or in Sparky Fire Departments and are learning fire safety through these means.

Another evidence of the continued growth in fire prevention education is the continued great virility of the observance of Fire Prevention Week in the fall. While Fire Prevention Week has been going on for many years, it continues to expand year by year. There is scarcely any community in the country today that does not have some exposure to the lessons of fire safety during Fire Prevention Week.

In the year-round contest for excellence in fire prevention activity conducted by NFPA, the Grand Winners in 1960 were Martinsville, Va. and Hamilton, Ontario. Class winners in the United States by population groups were Milwaukee, Wis., Fort Worth, Texas, Providence, R. I., Portland, Maine, Killeen, Texas, Martinsville, Va., and Evendale, Ohio. In Canada, the class winners were Hamilton, Ontario, St. Catharines, Ontario, Cobourg, Ontario, Nelson, British Columbia, Schumacher, Ontario, and Stony Plain, Alberta.

Still another evidence of the growing public interest in and concern with fire protection and prevention is the fact that NFPA distribution of educational literature in 1960 broke all previous records.

Moving Forward in Fire Protection

By Loren S. Bush, President
National Fire Protection Association

Mr. Herbert A. Leggett, in his editorial for "Arizona Progress," makes the observation, "All progress stems from the innate tendency of every organism to bite off more than it can chew." If this is applied to our attempt to move forward in fire protection, we have plenty to bite on as indicated by the fire record of last year.

One and a quarter billion dollars in property loss! Have you tried to analyze how much money that is? If a firm started business the day Christ was born with a capital of 1¼ billion dollars and was so poorly operated that it received no interest on its capital and lost money at the rate of $1000 per day, it would still have been in business on January 1, 1960. Not only that, but the treasurer could report that if business got no worse the firm could operate for 1492 more years. If the people who have lost their lives due to fire in the last ten years could be brought back and located in one locality we would have a new city of over 100,000 population. Certainly we do not need more incentive to urge us forward in solving our fire protection problems.

Probably the engineer's approach is as logical as any in carrying on a discussion regarding the advancement in fire protection. This starts out with a statement of the problem. What are the facts? Then, how can it be worked out or corrected? And then, who is going to tackle the job? Patrick Henry once said, "I have but one lamp by which my feet are guided and that is the lamp of experience. I know of no way of judging the future but by the past." So let us apply these questions to the past, present and future.

The Past

What was the problem at the end of the last century? The world was just beginning the industrial revolution, but changes came slowly compared to our present fast-moving world. Electricity was coming into common use for lighting and a few reckless individuals were driving around town in newfangled contraptions called horseless carriages. These were the new hazards and they were causing some fires, but the big problem was conflagrations. The Baltimore fire of 1904, then the San Francisco earthquake and fire of 1906, were the culmination of a series of multiblock fires. In general, water supplies were weak and unreliable. Fire departments consisted of untrained men with horse-drawn steamers guaranteed to squirt water over the church tower. Automatic sprinklers were in use but not too reliable.

That is a partial sketch of the conditions, but how did the fire protection people of that era attempt to meet the problem? Put in the fewest possible words, they started to develop standards. The National Fire Protection Association was organized and its first job was to develop standards for automatic sprinkler installations, soon followed by others. The National Board of Fire Underwriters wrote the first

Based on an address by the author at the NFPA Regional Conference held in Columbus, Ohio, November 14-16, 1960.

National Building Code as a recommendation for cities and intensified its studies and reports on the fire defenses and physical conditions in larger cities throughout the United States in an attempt to reduce the conflagration hazard. This later resulted in standards for public protection. Underwriters' Laboratories, Inc., was started in an attempt to reduce the fires caused by inferior electrical equipment by seeing that appliances passed minimum standards. This later spread to hundreds of other hazards and then to protective devices. The fire service, always ultraconservative, slowly moved into the era of automotive fire apparatus.

Who did the job? Mainly people from the fire insurance business. Nearly all the early members of the NFPA were connected in some way with fire insurance and a few from the sprinkler and other fire extinguisher industries. This was natural because these people were in the best position to observe the disaster and see the need for standards to bring order out of chaos.

The Present

What is the situation today? We find ourselves in a rapidly changing world where hazards are developing faster than fire protection and we sometimes wonder if this "pursuit of happiness" has not become more of a rat race than the founding fathers intended. Probably our biggest problems are the loss of life fires and those which cause heavy property damage. This of course does not mean that we have solved the problem of conflagrations, but because of modern industrial demands we have tremendous values subject to one fire. This tendency extended to mercantile occupancies, first in the form of supermarkets, then shopping centers, and now shopping malls. New types of building materials and new forms of construction have created problems in fire resistance and method of attack. New sources of energy create nuclear hazards never heard of before and dangerous chemicals formerly found only in laboratories, if at all, are now being transported through our streets in tank trucks. The advent of modern aircraft has brought a whole new series of problems in safety to life and property. The delayed alarm problem is still with us and the increased cost of fire fighting man power adds to the headaches in trying to keep even in fire protection. This, of course, is but a sample of the present problems, but let's see how this generation has attempted to solve them.

The same organizations have expanded in developing standards. The National Fire Protection Association now publishes about 185 and other organizations have been formed to help in this work. These include the Factory Mutual Laboratories, and many others. Through these organizations standards have not only been expanded but kept up to date by annual review and frequent revisions. Among the organizations from which we obtain strong support are the Society of Fire Protection Engineers, the Fire Marshals Association of North America, the International Association of Fire Chiefs, and the Fire Department Instructors Conference.

An extensive research program is finally under way, but anyone who expects immediate and astounding results is doomed to disappointment. Research does not work that way; some developments do look encouraging, however, and may lead to an entirely new approach in fire extinguishment. More effective use of water has been developed through use of spray in fixed systems and fire department nozzles, as well as detergent additives. New types of extinguishers have been developed to meet specific needs in controlling fires; these

include foam, carbon dioxide, dry powder and, now, an all-purpose extinguisher. Through the development of standards for municipal fire apparatus, sponsored jointly by NFPA, National Board of Fire Underwriters and International Association of Fire Chiefs, highly efficient automotive apparatus has been produced, and just last month the first turbo-jet propelled pumper was delivered to San Francisco. The aerial platform truck is the most recent development in aerial equipment.

Automatic protection, both sprinklers and fire alarm, has expanded greatly in this generation, but not nearly fast enough to solve the problem. Fire prevention has developed almost entirely in this century, but the most recent improvements are home inspections and in-service inspections made possible by the advent of two-way radio in our fire departments.

Just as it was impossible to outline all the problems, it is just as impossible to list all the innovations in fire protection developed in the last half century, but let's see who is doing the work. No longer is fire insurance carrying the big load. The largest percentage of NFPA members comes from industry and commerce, the next largest from the fire service and other governmental agencies and fire insurance comes third. The National Academy of Sciences and several laboratories throughout the world are working on research problems. There are 1500 experts on our 110 technical committees; our army is growing and it is more diversified, but we are slipping behind.

The Future

We cannot quit while we are losing, so what about the future? It seems to be a policy of this generation to build problems for the next, so what do they face? Let's take a look at the cities of the future.

The Committee on Economic Development in its report based on data from the 1960 census gives us some hints along this line. They state that two-thirds of the American people live in 192 metropolitan districts and are governed by some 16,000 local jurisdictions. They believe that this unusual growth of the metropolitan districts is due to a large extent to the fact that less labor is needed on the farms and this condition will doubtless increase as farms become more and more mechanized. An interesting fact is that 80 per cent of this growth has gone to the suburbs rather than to central districts and no doubt this trend will continue.

The Committee points out the difficulty in budgeting and planning in these areas due to the multiplicity of governmental jurisdictions and concludes with this statement, "Failure to establish metropolitan government with wide powers will lead to greater loss of self-determination in local affairs through continuous transfer of responsibility to State and Federal governments."

It is not likely that cities will stand by and let this happen. At any rate it seems logical to assume that there will be some kind of consolidation of governments in our metropolitan districts and this means more co-ordination if not actual consolidation of the fire defense systems.

Mr. William L. C. Wheaton, Urban Studies Director at the University of Pennsylvania, in an article based on this very obvious growth of our cities gives a picture of three ways that they might develop. He estimates that the suburbs of our American cities will double in size by 1970 and double again by 1980 and they may be unable to accommodate their future populations without far

more systematic planning. The three choices indicated in Mr. Wheaton's article are:

1. The high-density or skyscraper type, like New York's Manhattan.

2. The medium-density or satellite-type city like London with a concentrated central area surrounded by compact, self-contained towns.

3. The lower-density or urban-country type more like Los Angeles. He does not think that it is beyond the realm of probability that our cities will extend 100 miles in length or even as much as 300 miles. Probably most cities in these population centers will be a combination of all three types with each connected by freeways.

Here is one for our Committee on Fire Department Organization. Consider the problems in administration, running cards and station locations. There is no doubt that hazards will continue to increase at a faster rate and construction will present even greater problems.

How will these problems be solved? It would be easy to get beyond one's depth in attempting to answer that question, but some trends seem to be indicated. More automatic protection, for instance, is way past due and someone will conceive of a plan that will provide it economically. More intensive and better training for fire departments will be essential and fire department equipment will become more specialized. Fire prevention programs will be greatly stepped up with more and better-trained men. One lesson that seems obvious from our past and present experience is that fire prevention, to be effective, must be concentrated where the hazard exists and that means inspections, inspections and more inspections by people who know what they are looking for. Then better and more educational facilities for fire protection engineers must be provided, for this is the source of leadership in fire prevention bureaus, in industrial safety and in planning the campaigns against this loss of life and property by fire.

Probably the most important question of all is, who will solve the fire protection problems of tomorrow? The younger readers of the QUARTERLY, no doubt, will play important parts in the solution and some will be leaders, so these concluding remarks are addressed to them. Your job will not be to tell people what cannot be done, but to show them how to do what they want to do safely. One of the principal reasons for this publication is to help you qualify yourself for that position, but you must do most of the work yourself. First you must be devoted to your job; fire protection must be a part of you as it has been of the leaders in the past and present. We have not provided many formal schools in fire protection engineering so you will have to read and read and read. Mark Twain says regarding reading, "There is little difference between those who don't and those who can't."

It will make little difference what the problems are or how to solve them if we do not develop the men who can and will do the job. With a background of devotion to service and reared in an atmosphere of rapid change, it is obvious from the past that you will be far better qualified than we of this generation who can only point out a few rocks in the course you are about to follow. The "Who" is far more important than the "What" and "How." As the poet expressed it in a few words:

One ship drives East, another West
With the self-same gale that blows.
'Tis the set of the sail and not the gale
That determines the way that it goes.

Aircraft Crash-Fire-Worthiness

By George H. Tryon, Assistant Technical Secretary

National Fire Protection Association

Member, Society of Fire Protection Engineers

"Crashed and Burned."

This phrase has become so common in newspaper reports of aircraft accidents that when an accident occurs where no fire is involved, the newspaper makes special mention of the fact that "there was no fire."

This is an indictment of aircraft design. It represents a major failure which can only be laid at the doorstep of aeronautical engineers. It is time some attention is given to the "crash-fire-worthiness" of aircraft.

As common as impact fires are, investigating authorities have paid scant attention to the problem. They have been investigating the crash; they have been ignoring the burn! Indeed, it would appear from an international review of accident reports that investigators are more annoyed by the fact that evidence is destroyed through destruction by fire than they are concerned about the fire itself!

The neglect to incorporate in aircraft adequate "crash-fire-worthiness" and the failure to investigate aircraft crash-fire behavior is needlessly costing lives. While some miraculous escapes have occurred, such as following the Electra accident at La Guardia Airport in September, it has been clearly established that in survivable types of accidents involving fire, escape and rescue are severely complicated, resulting in an increased proportion of fatalities where fire does follow impact.

Based on an address by the author presented at the Flight Safety Foundation's 13th Annual International Air Safety Seminar, held in Chandler, Arizona, Nov. 14–18, 1960.

NASA Test Data

The National Aeronautics and Space Administration did some very effective aircraft crash-fire tests during the period from 1949 until 1952 as reported in the October 1953 NFPA Quarterly. These tests, conducted with C-46 and C-82 aircraft, were purposely designed to create a high incidence of fire so that studies could be made of the mechanism of crash fires with particular emphasis placed on the type of crashes which occur at take-off and landing speeds where the likelihood of persons surviving the impact forces is high. The results of the work indicated that significant reductions in crash-fire hazards could be realized by design measures and, furthermore, that it was practical to develop ignition source inerting systems to prevent crash fires which originated from aircraft ignition sources. This highly important and significant work, and the subsequent work done by the NASA with turbine engines and turbine engine crash prevention systems, has unfortunately never progressed significantly from the experimental stage to the operational stage. While air-frame and power-plant manufacturers deny responsibility for failure to incorporate such crash prevention systems into aircraft on the basis that their customers do not demand this protection, the operators excuse themselves on the basis that refined techniques of providing this type of protec-

The Electra which crashed at New York's La Guardia Airport was one of the fortunate "crashed and burned" cases as all 76 aboard got out alive thanks to (1) seat belts, (2) relative low deceleration and impact forces, (3) easy opening of a lounge emergency exit (at arrow by fuselage in the photo) and the availability of two other passenger exits, (4) the operation of the exterior release at the cockpit window by a heroic passenger, (5) the fact that the aircraft inverted and passengers could walk relatively easily on the "ceiling" to the exits and had only a short step to ground and (6) the fact that the left wing became detached and fire was not on all sides of the aircraft simultaneously as the aircraft came to rest.

All occupants escaped before airport apparatus could reach the scene 2½ minutes after the Control Tower gave the alarm. The arrow at the runway threshold is where the Electra landing gear struck the dike short of Runway 31.

The Electra had 2,090 gallons of Type A (kerosene) fuel aboard at the time of the crash. Due to effective fire control, 350 gallons of fuel remained in the right wing after extinguishment with foam and dry chemical by the well-equipped airport fire department. (For a more complete report, see the NFPA *Fire News* for December 1960.)

British European Airways Photograph

The extent of damage to a Viscount 802 after the nose-wheel unit was overstressed in a landing at London Airport during low visibility conditions. The way the fire spread to gut the fuselage with no involvement of the wing fuel tanks tells an interesting technical story on the vulnerability of the occupied portions of these aircraft to fire damage. The fire started either from friction ignition of leaking hydraulic fluid resulting from sparks when the oleo-leg from the collapsed gear rubbed on the runway (as indicated in the official report) or from friction of the collapsed nosewheel rubbing against the baggage hold directly above. From here the fire burned a hole through the metal floor of the galley and because all the doors and two rear emergency exits were open (to permit the 54 passengers and 5 crew members to escape successfully) a chimney effect was produced which caused the damage shown.

Airport fire crews were delayed 8 minutes in reaching the scene by the dense fog conditions and this prevented as prompt control as might otherwise have been possible by the well equipped and manned London Aerodrome Fire Service. The need for more effective communications using the airfield surface movement radar by the tower and fire appliances was learned from this experience.

tion have not been exhibited by the suppliers. Others take the attitude that aircraft are built to fly, not to crash, and that until regulatory authorities demand crash-fire prevention systems, no one will take a serious interest in incorporating these safeguards into operational aircraft. A "buck-passing" game has been going on prejudicing progress in this field.

While the NASA tests were devised in such a manner as to create a high incidence of fire, it should also be observed that the aircraft employed in the test program were necessarily obsolete aircraft (C-46's and C-82's) which really do not have, from a design point of view, as serious crash-fire characteristics as do many modern-day operational transport category aircraft. The C-46, with its separate metal tanks, and the high wing design of the C-82 are aircraft designs not truly symbolic of the in-built crash-fire hazards of the modern-day transports, with their integral fuel tanks, with their wing center-section fuel tankage, with their landing gears mounted on fuel tank supporting structures, with their increased use of magnesium components, and with all their other design hazards and increased fuel loads. It is thus apparent, even to the casual observer of the crash-fire behavior patterns of transport category aircraft in current usage, that many problems exist in these aircraft from the crash-fire viewpoint that did not exist in the test articles used by the NASA in these celebrated tests.

Two Interesting Crash-Fire Reports

Space does not permit a comprehensive review of accident reports and, as mentioned earlier, most accident reports are deficient in their treatment of the crash-fire details. Two recent reports, however, are of some special interest and perhaps symbolic of the crash-fire hazard of modern-day civil transports.

London, January 7, 1960

The Ministry of Aviation in the United Kingdom has issued a report on the accident which involved a Viscount aircraft at the London Airport on January 7, 1960. The aircraft involved in the accident landed at London Airport under adverse weather conditions after a scheduled flight from Dublin. The official opinion rendered indicated that the accident was caused by the failure of air traffic control to notify the Captain of a critical deterioration in the runway visual range during the final approach. In consequence, the pilot attempted to land in a visibility which gave him insufficient visual reference with the result that the nose wheels contacted the runway before the main wheels, thereby overstressing the nose-wheel unit and fracturing its attachments.

The portion of this report that bears quoting concerns the fact that "the most significant damage caused during the collapse of the nose-wheel unit was the fracture of the main hydraulic pipe feeding the steering jack." The hydraulic oil, at high pressure, was released in the form of a spray onto the tires and surrounding structures and probably onto some of the baggage in the forward hold after the fuselage was punctured. The escape of the hydraulic oil (flash point: 203°F) was considered by the investigators to be the "prime factor in the fire which ensued." They theorize that the ignition source was the frictional heat developed by the ruptured nose-wheel strut after contact with the runway, and this is supported by their research indicating that a temperature of the order of 1,000 degrees Fahrenheit was reached during the time the aircraft was skidding along the runway on its nose. After the start of the fire in a small pool of hydraulic fluid burning under the forward fuselage, flames progressed into the forward luggage bay above the nose-wheel. Because all the doors in the fuselage and the two rear emergency exits were opened and because of the hole made in the underside by the nose-wheel, a chimney effect was produced in the fuselage which rapidly intensified the fire and accelerated its course rearward. By the time fire service appliances arrived, a fierce fire had burned through the top of the fuselage to the rear of the cockpit and had spread back as far as the front of the passenger cabin. It subsequently burned rearward above the floor level as far back as the tail unit, and almost the complete fuselage was destroyed. Interestingly enough, the wings were not damaged by fire and the fuel-containing structures remained substantially intact. This is one of the very few crash-fire incidents where investigators paid serious attention to the fire cause and the factors responsible for its spread. There is not unanimous agreement on the role which the hydraulic fluid played in this accident but, at any rate, the spread of fire was analyzed by the investigating board.

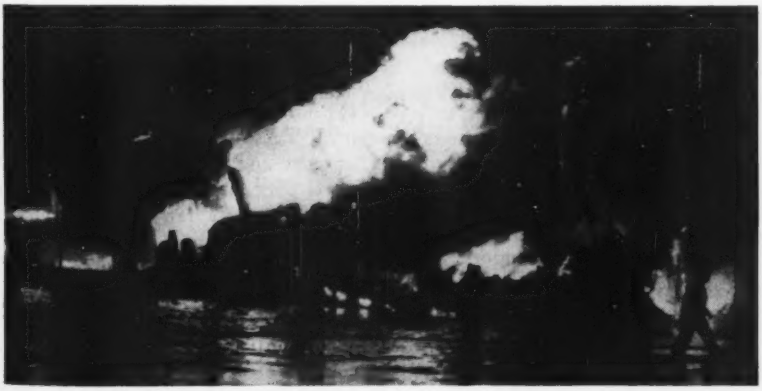
Montego Bay, Jamaica, January 21, 1960

The second accident report that is of interest concerns the tragic accident at Montego Bay, Jamaica, also in January of 1960. In this case a Super-Constellation made an initial hard contact with the runway, bounced into the air, and re-alighted on the runway. The fire started almost immediately

after the second contact with the runway. The fracture of the left wing through the No. 2 fuel tank released the fuel which ignited. As the fuselage and the left wing proceeded along the runway and across the grass verge and into a swampy area, a trail of fire was left behind. When the fuselage finally came to rest, it was inverted and fire was burning almost all the way around it. The nine survivors came from either end of the aircraft — three members of the crew from the cockpit and four passengers and two members of the crew from the rear passenger compartment. So fierce was the fire exposure that in the opinion of the medical expert, life in the aircraft would have been impossible within three minutes of the start of the fire. Special note is taken in the report how the narrow aisle in the tourist section of the aircraft hindered prompt movement to the exits. The fire was sustained by 2,600 gallons of aviation fuel on board at the time.

This second accident illustrates the more "common-breed" of crash-fire tragedy — the kind that gets its lethal punch from the extreme vulnerability to impact damage of integral fuel tankage of today's transport aircraft. This brings up the failure of the industry to pay serious heed to the Civil Aeronautics Administration's* research on crash-resistant fuel tanks — a failure which has been encouraged by a similar

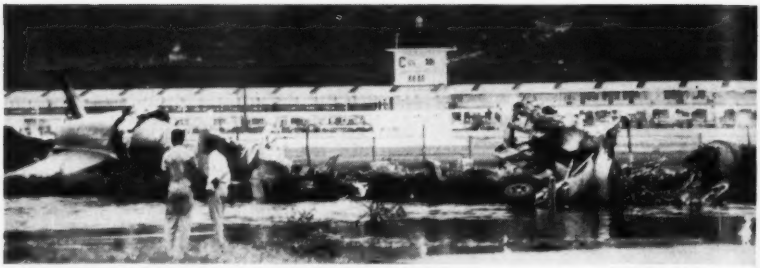
*Now known as the Federal Aviation Agency.



Wide World Photo

The hopelessness of crash fires such as this one at Montego Bay Airport, Jamaica is an indictment of aircraft design in the opinion of the author. The hard landing caused a fracture of the left wing through the No. 2 fuel tank since the landing gear is mounted on the same structural support as the integral fuel tankage. The released fuel ignited and the fire was so fierce that life in the aircraft was judged by the medical expert to be "extinct within three minutes of the start of the fire."

It was reported in the press that when the surviving flight engineer opened the cockpit door to the main passenger cabin seconds after the aircraft came to rest, "he was met by a solid wall of flames." He slammed the door shut and got out with the captain and co-pilot through the cockpit windows. The only others to escape were two other crew members and four passengers in the aft cabin; one (the steward) got out via the starboard emergency exit but the others had to use a port emergency window as flames barred following the same route as the steward. In all, 37 of the 46 occupants of the aircraft died in the flaming wreckage.



Wide World Photo

A post-fire view of the Constellation fire at Montego Bay, January 21, 1960. Note how the fuselage is gutted from nose to tail.

The Airport fire service included a foam tender, a nurse truck and a rescue tender and nine men on duty. A member of the fire service on lookout sounded the alarm even before the Air Traffic Control Officer and their response was rapid having to travel only a few hundred yards to the scene. Yet, the fire was so intense and severe that they were not able to reach the fuselage for perhaps 20 minutes. Undoubtedly the rate of discharge of foam was not what one could expect from modern U. S. aircraft rescue and fire fighting appliances, but, even if it were, could rescue have been possible in the three minutes during which life was estimated to exist on board?

The official report also noted that in the tourist section, the seat arrangement (3 on one side, 2 on the other) hindered quick movement to the exit windows and where the exit windows are at the front of the compartment (as was the case in the compartment for 20 tourists) the "situation seems to lend itself to the clogging of the passageway."

failure of accident investigators to lay this problem "on-the-line" in the multitude of cases where impact damaged fuel tanks have been the primary villain of aircraft accident fire-deaths.

NFPA Aircraft Fire Reports

For the last 14 years, the NFPA has been attempting to gather technical information on which to write analyses of all aircraft fire incidents. During this period the Association has solicited from fire departments, aircraft operators, airport authorities, air frame manufacturers, the military services, the Civil Aeronautics Board, state aeronautical commissions, and similar organizations in other countries, the technical details on the fire aspects of aircraft accidents. The Association has published quite a number of reports on those accidents for which adequate data were available in this QUARTERLY, in the NFPA *Fire News* and in Aviation Bulletins. These reports have not been as complete and detailed as desired but the efforts expended by the Association to get a full-time aviation field service engineer have not been successful to date. It was hoped such a specialist would be in a position to make his own accident investigations of these incidents so that more detailed analysis could be made of how the fire started, how the fire spread, and how the fire affected the occupants of the aircraft. Efforts to stimulate interest in investigating more fully the crash-fire aspects of these accidents by the present official investigating bodies have been unsuccessful, primarily since most such bodies, as the Civil Aeronautics Board (U.S.A.), have been limited in authority and manpower so that they can investigate only the "probable cause" of accidents and not factors contributing to their severity.

What Should Be Done

It is vitally important in all fire investigation work, whether the fire involves a building, industrial process equipment, forest and brush, aircraft, or any other transportation vehicle, to know what goes on during the first five minutes of the fire. This means, as far as aircraft crash-fire investigation is concerned, that research should follow each accident to pin point the ignition sources; the fuel vapor release points; the amount and sources of fuel spillage; how the fire spread; resistance of the fuselage to flame and heat attack; the penetration of the fuselage (such as at wing roots); contribution to the fire of the insulation materials, the upholstery and the decor; how the fire handicapped evacuation and rescue efforts; the nature of the injury to victims and an analysis of whether those injuries were occassioned by impact forces, burns, or suffocation.

Fuels and Ignition Sources

An intelligent investigation of the fire aspects of aircraft accidents would require evaluating the primary fuels involved, whether they be aviation gasoline, the gas turbine fuels, lubricating oils, hydraulic fluids, magnesium or titanium metals, combustible fabrics, the baggage or the freight. It would require a study of the primary ignition sources as they exist in the power plants, such as the exhaust system piping, backfires caused by sudden engine stoppage, hot engine surfaces, the carburetor, damaged propeller mechanisms, the supercharger, the generator or other electric system components, or an operating turbine engine. As shown in the NASA report, electrical short circuits in the wing section were responsible for many of the fires sustained during their test program. The positioning of landing lights was found to be particularly critical, as were designs which permitted the flow of spilled fuel either within the aircraft structure or on the underwing surfaces toward the nacelles or other ignition sources. None of this electrical equipment is of the "explosion-proof" type and yet is in such close proximity to the fuel tankage that it seems to be a most unnecessary risk. In another series of tests, the NASA proved the fuel vapor ignition potential of certain aircraft metals, such as stainless steel, magnesium and titanium, resulting from friction sparks as can occur during a wheels-up landing or after gear collapse when these metals might contact runway surfaces. They showed that fuel vapor ignition could occur even from electrostatic accumulations on wing surfaces and even on landing gears which could result in arcs upon ground contact.

Another NASA finding, which many people are today attempting to overlook, is that Type A (kerosene) turbine fuels in mist form present no distinguishable difference in the crash-fire hazard picture from the more volatile aircraft fuels, aviation gasoline and the Type B turbine fuels.

Way Fires Spread

No less important than discovering ignition sources in crash-fire incidents is analyzing the way the fires spread. The location and causes of failures of nacelle, wing, and fuselage skin surfaces by flame and heat attack would give vital clues. NFPA studies indicate clearly that one of the very major problems is the fire spread through wing roots into the fuselage compartments. Detailed study should be made of the behavior of integral fuel tanks and the present-day bladder-type tanks. No less important is the crash resistance of fuel plumbing, and attention should be paid to cases where lubricating oil and hydraulic fluids, as well as magnesium and titanium, are indicated as contributing to the spread of fire. A careful

analysis of fire progress routes should be made, including the effectiveness of "fire walls," the resistance of different aircraft metals to flame penetration, and how fuselages become chimneys when emergency egress doors are opened. Special attention should be paid to the contributions made by aircraft oxygen systems, by sound-deadening materials, insulation adhesives, and doped fabric surfaces.

Urgency Cited

The need for more complete investigations into aircraft crash-fire behavior is becoming increasingly urgent as the occupancy density of aircraft increases in the modern turbine powered aircraft, as fuel quantities triple, as aircraft grow increasingly larger in wing span and fuselage lengths.

Limitation of Manual Fire Control

One of the primary efforts of the NFPA has been aimed at encouraging the provision of aircraft rescue and fire services at airports designed essentially to provide "five minutes of protection" in the hopes of achieving rescue or aiding evacuation of aircraft in event of a crash-fire incident on the airport or its immediate environs. It is noted with some satisfaction that in September 1960 the Federal Aviation Agency adopted as that Agency's policy the provision of airport rescue and fire-fighting equipment in accordance with these NFPA suggestions. All of us, however, who have been engaged in evaluating and estimating the need for this equipment realize the inherent limitations of mobile fire-fighting apparatus to handle serious crash-fire incidents, and are keenly aware that the magnitude of the risk involves unacceptable odds, odds which are becoming more and more unfavorable as aircraft increase in carrying capacity, in fuel load, in dimension, and in complexity.

Call for Action

This appeal for greater attention to the investigation of aircraft crash-fire behavior is an urgent one. It is based upon the dread which accompanies the first reports of every accident that still another aircraft has "crashed and burned." It is time all investigative authorities search out and label those factors in aircraft design responsible for, or contributing to, the initiation and spread of fires following "survivable" crashes and the related factors responsible for entrapment of aircraft occupants. The air-frame and power-plant manufacturers, along with airline, military and other operators, are urged to study these accidents from this viewpoint toward the objective of improving the "crash-fire-worthiness" of the aircraft they build or operate. Such actions could stop these needless sacrifices of life resulting from fire following crash which will continue in increasing proportions unless such a program is placed in effect.

LP-GAS TANK TRUCK FIRE AT FORT DEVENS

By Clark F. Jones, Gases Field Service
National Fire Protection Association
Member, Society of Fire Protection Engineers

A fire occurred at 9:10 a.m., July 15, 1960, at Fort Devens, Massachusetts, a U. S. Army Post, when LP-Gas liquid escaped from a broken 2-inch hose connection underneath a tank truck during delivery to a 500-gallon storage tank. The released LP-Gas was probably ignited by gas-fueled kitchen equipment in a nearby mess hall.

Approximately 15 minutes after the initial hose failure, the large cargo tank on the truck ruptured near the top of the front head. This failure was apparently due to localized heating as the top of the head was in direct line of the vent discharge from a safety relief device on an LP-Gas saddle tank. Three persons were burned when the tank ruptured. The fire destroyed the LP-Gas tank truck and a nearby Army truck. Two 1-story wooden mess halls were badly damaged and paint was blistered on four 2-story wooden barracks buildings in the area.

Prompt action by the Fort Devens Fire Department limited the extent of the fire and brought it under control within 40 minutes. Quick recognition of the danger by military personnel and the immediate warning and evacuation of those in the area prior to the rupture minimized personnel injuries.

The Tank Truck

The LP-Gas tank truck had about 7,360-gallon water capacity and was built between 1956 and 1958. The shell thickness was 0.54 inches and the head thickness was about 0.231 inches with hemispherical heads. The tank was

U. S. Army Photograph

Photo 1. During transfer of LP-Gas from this transport truck to a 500-gallon storage tank a 2-inch metal-reinforced rubber hose connection between the pump and meter ruptured. Location of the ruptured hose was beneath the cargo tank about midway between the front and rear. Escaping gas ignited before the main valve in the pipe from the tank to the pump could be closed.

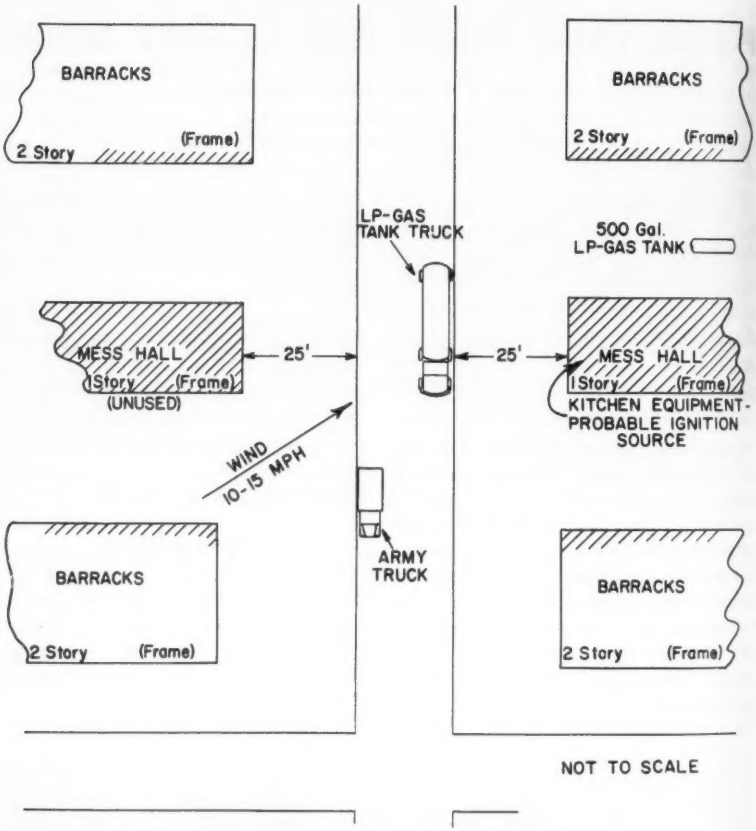


Figure A. Sketch of the scene of the LP-Gas tank truck fire at Fort Devens, Massachusetts. Burned parts of buildings are indicated by diagonal lines.

installed on a semi-trailer without framing as shown in Photo 1. The cargo tank, plus running gear, was supplied by the tank truck manufacturer. The pump drive, meter, and piping were installed by the owner after delivery. The piping included a 3- to 4-foot length of 2-inch metal-reinforced rubber hose that connected the pump and meter, both located beneath the middle of the tank. The pump and piping were apparently arranged by the owner so that the truck could be used for delivery as well as for bulk transport purposes. This involved considerable rearrangement of piping for a dual purpose vehicle.

What Happened

The driver parked the tank truck, as shown in Figure A, and started his pump. After connecting liquid delivery and vapor return hose lines to a 500-gallon LP-Gas storage tank located alongside the mess hall, he started to fill

Photo 2. The broken 2-inch metal-reinforced rubber hose is shown in center foreground. Directly behind and beneath the hose may be seen the main valve in the pipe from the tank to the pump. The truck driver was not able to reach this valve due to escaping gas.

U. S. Army Photograph

the tank. The 2-inch hose connection from the pump discharge to the meter then ruptured. The driver returned to the truck, reached underneath in an attempt to close the main valve in the 3-inch pipe between the tank and pump but could not get to it due to the leak. (See Photo 2.) Instead, he shut off the pump motor. There was a 3-inch excess flow valve at the tank. It did not close however, because the leak in the 2-inch hose connection on the discharge side of the pump was not at a sufficient rate to operate the valve. The liquid continued to escape.

About two minutes after the rupture occurred, the released LP-Gas ignited. Kitchen cooking equipment located in the mess hall about 25 feet from the truck was a possible ignition source. Since the leaking LP-Gas line could not be shut off, the fire continued to burn beneath the tank truck and the ensuing fire soon enveloped the entire truck, including the truck pump hydraulic system and the LP-Gas saddle tanks beneath either side of the cab. Simultaneously with the initial ignition, fire had broken out in the mess hall where kitchen equipment was operating.

Heat from the fire caused safety relief devices on the saddle tanks to open. Vent lines from these devices were connected through 45° elbows and short lengths of rubber hose to a single pipe line going to the top of the rear of the cab. These hoses quickly burned off so that the elbow on the top of one of the safety relief devices now directed the discharge at a 45° angle upward and toward the top of the front end of the cargo container. Thus, a hot spot developed on the upper portion of the head, above the liquid level, so that the container was weakened at this point. The head bulged and thinned out opening a hole in the container about 18 to 21 inches in diameter. (See Photos 3 and 4.) When this opening developed, the release of LP-Gas caused a sudden burst of flame intensifying the fire and causing an unoccupied mess hall on the opposite side of the street from the LP-Gas truck to ignite. Spectators reported that when the failure occurred a loud "WHOOSH" or tearing sound was heard. It was reported that this

U. S. Army Photograph

Photo 3. The end of the 45° elbow from the pressure relief device on the right saddle tank is circled. There was a similar elbow on the left saddle tank and both elbows were connected by short lengths of rubber hose to a common vent pipe that terminated above the top of the cab. When the rubber hose burned off, burning gas from the elbow shown in the photo impinged on the tank head near the top.

failure occurred approximately 15 minutes after the initial hose failure.

The Post Fire Department arrived promptly upon being alerted. At first they used hose streams to put water on the container of the tank truck. However, because electrical wires had burned and were dropping on the tank, they were apprehensive of the possibility of electric shock and discontinued wetting the tank. Instead, they turned their hoses on nearby buildings to reduce the fire exposure damage. The ends of the two mess halls toward the transport on each side of the driveway were badly burned. Four of the nearby 2-story wooden barracks buildings were singed or charred by radiant heat and by flames whipped toward them by winds. Total building damage was estimated to be slightly below $100,000.

Recommendations

This accident again emphasizes the need for further review and study of LP-Gas tank truck requirements as outlined in NFPA No. 58, Standard for the Storage and Handling of Liquefied Petroleum Gas. The following suggestions are submitted:

(a) The main shutoff valve was located underneath the cargo tank and behind the pump. It was also inaccessible from the opposite side of the truck as it was behind the hydraulic reservoir and LP-Gas delivery hose reel. This seems to reaffirm our previous recommendation (Fatal LP-Gas Tank Truck Fire — October 1959 QUARTERLY) in which we recommended provision of an automatic, internal, quick-closing valve.

(b) All LP-Gas tank trucks should be inspected to make sure that all piping, equipment, and accessories will function as intended. Frequent inspection of valves, piping, pumps, hose, flexible

U. S. Army Photograph

Photo 4. Photo shows hole near top of front hemispherical head. The head became weakened when burning gas discharging from a saddle tank relief device impinged on the tank head above the liquid level line.

U. S. Army Photograph

Photo 5. This photo was taken after the cargo tank had ruptured. Flames are spreading through mess halls on either side of the road. The Post Fire Department limited serious damage to these two buildings, the LP-Gas tank truck and an Army truck parked near it.

connections, and the testing of excess flow valves should be done to assure proper operation.

(c) The use of hose as an integral part of the piping system is not permitted by Paragraph B.8 (a) of NFPA Standard No. 58. However Paragraph B.8 (j) does permit the use of flexible connections. It is recommended that short lengths of flexible metal connectors of proper design be used.

(d) Observe Paragraphs 3.4(a) and 4.6(b), of NFPA Standard No. 58 which would prohibit the use of rubber hose in safety relief device vent lines to be certain that the gas discharge from these lines does not impinge on the container, any other container, or other vehicle.

Acknowledgments

This report records the personal observations of the author who visited the scene of the fire and explosion by invitation of U. S. Army authorities.

We acknowledge with sincere thanks the helpful assistance given by U. S. Army authorities and others who have contributed to this report.

Wide World

Largest 1960 Large Loss of Life Fire in North America occurred during the morning of December 19, when flames burst through the carrier "Constellation." The blaze took 50 lives and injured many others. A preliminary report appeared in the January, 1961 *Fire News*.

Large Loss of Life Fires of 1960

An NFPA Fire Record Department Study

During 1960 in the United States and Canada 566 men, women, and children died in 80 fires and explosions killing 5 or more persons.

Last year the Fire Record Department published the first large loss of life story.* In that study, which included only those fires and explosions in 1959 causing *six* or more deaths, there were 53 cases resulting in 441 deaths. In 1960 the six-or-more-death tragedies numbered 39 and killed 361 persons.

The previous study of 1959 fatalities indicated that most residential fires causing 6 or more deaths involved extremely substandard homes that were not typical of the dwellings in which a large majority of residential fire fatalities occur. For this reason it was decided to broaden the base of experience by revising *the definition of a large loss of life fire* to include those in which *five or more deaths* occurred. As will be noted from a study of the record on the following pages, this change has resulted in the inclusion of a substantial number of fires in all types of dwellings. The lessons of this study, therefore, have much wider application.

Fires and explosions in thich *four* lives were lost have been listed in this year's study. There were 71 such fires killing a total of 284 persons. Fifty-seven of these 4-death fires occurred in residential occupancies, including 42 in dwellings.

To broaden still further the large loss of life experience it is tentatively planned to include analysis of 4-death experience in the 1961 summary to be published a year from now.

*Large Loss of Life Fires of 1959. Published in July 1960 issue of the NFPA QUARTERLY.

Statistical Summary

Of the 80 fires causing 5 or more deaths, 8 resulted in 12 or more fatalities. The largest loss of life by fire occurred Dec. 19, in New York City when the carrier "Constellation" burned, killing 50 shipbuilders. The next largest was the crash and fire of a chartered C-46 in Toledo, Ohio, killing 22.

Sixty-three per cent (357) of the 566 victims of large loss of life fires died in building fires. The remaining 37 per cent died in "nonbuilding" fires. Of the 209 "nonbuilding" fatalities, 172 died due to fires in transportation vehicles, 23 died in underground fires, 8 fire fighters died in the line of duty, and 6 persons died in a chemical plant explosion in outdoor equipment.

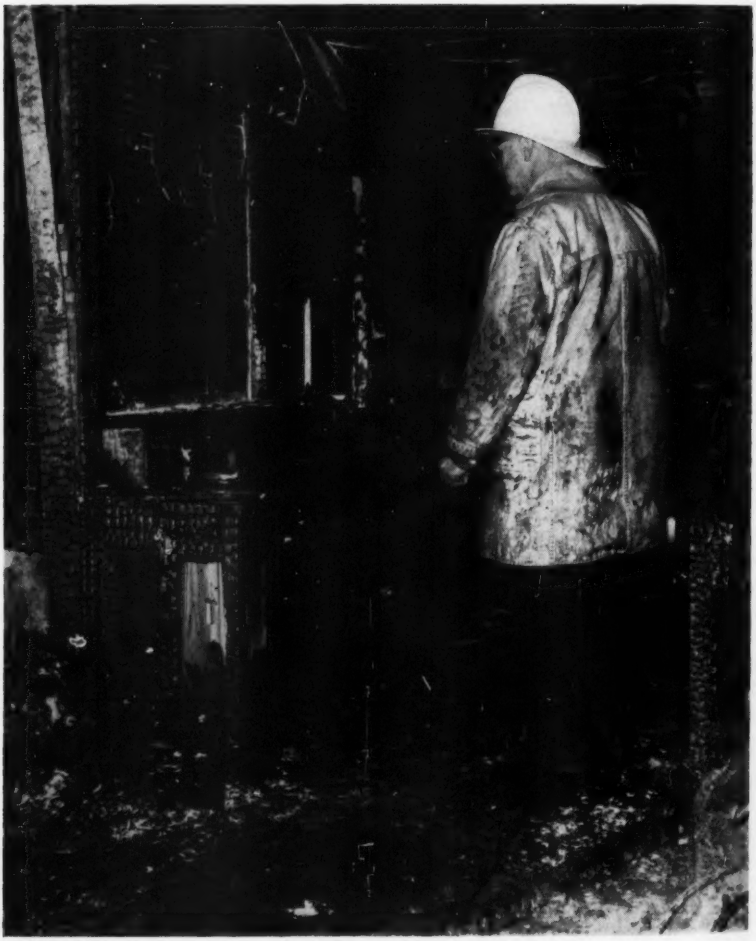
Sixty-nine (69) of the large loss of life fires causing 494 deaths occurred in the United States; the remaining 11 fires, responsible for 72 deaths, occurred in Canada.

The following table shows the number of people killed and the number of large loss of life fires by occupancy classification.

	Number Killed	Number of Fires
Residential	309	54
Transportation	172	16
Industrial	26	3
Mercantile	30	4
Underground	23	2
Storage	6	1
Total	566	80

Acknowledgment

Many people provided the NFPA with the factual reports on which this study was based: NFPA members who have voluntarily sent notice of these fires; fire chiefs and city fire marshals who have reported the facts and figures on these fires, often at the cost of additional time and effort on their part; the state fire marshals and other state and government officials who have spent time checking records to see that the list is as complete as possible and who themselves have produced needed facts for the analysis. Without this help and interest there would have been no story.



Wide World

Typical of Large Loss of Life Residential Fires was this 1:07 A.M. fire in a single family dwelling in Ashland, Mass. A living room fire, an open stairway to second floor bedrooms and delayed detection were responsible for the deaths of all five occupants. Details reported on page 244.

1960 Large Loss of Life Fires —

In Residential Properties

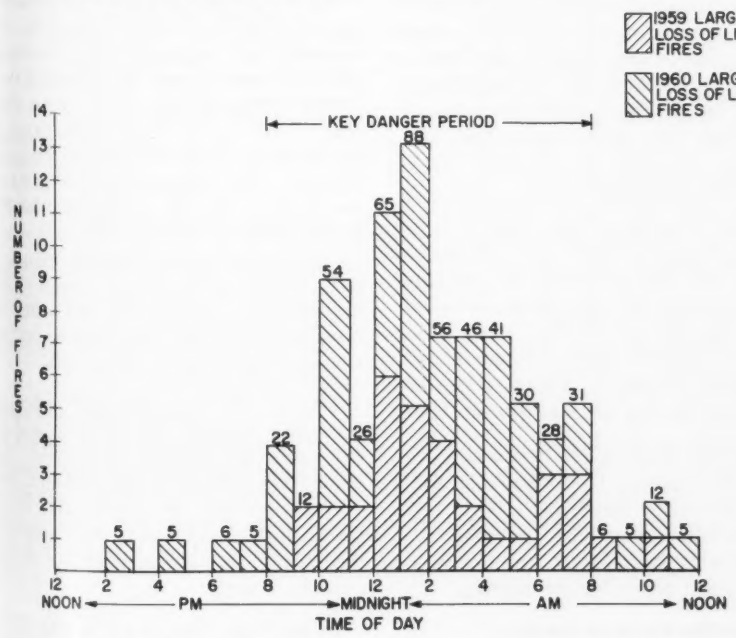
Three hundred and nine (309) persons were killed in 54 residential large loss of life fires in the U. S. and Canada in 1960. These fires, each responsible for *five* or more deaths, occurred in the following occupancies:

	Number Killed	Number of Fires
Dwellings	261	46
Apartments	28	5
Hotels	15	2
Rooming houses	5	1
Total	309	54

Month of Fire

The worst month of the year for residential large loss of life fires was November with 55 persons dying in 11 fires. The best month was June which had no fires in which 5 or more died. The following table shows the variation in large loss of life experience by season. Factors that may explain the greatly increased number of fires and deaths in winter months are heating systems, confined children, and low interior humidities.

	Number Killed	Number of Fires
January-March	121	21
April-June	24	4
July-September	29	5
October-December	135	24
Total	309	54



Graph I. Large Loss of Life Fires 1959 and 1960 — Number of Fires by Hour. The number at the head of each column is the number of persons killed per hour interval.

Hour of Fire

The time of fire for the 54 large loss of life residential fires in 1960 is shown in Graph I. To emphasize the fact that there is a time-of-day pattern into which most large loss of life fires fall, the 1959 experience is also shown on the graph. Ninety-one per cent of the people who died and 90 per cent of the total fires for this two-year period occurred between the hours of 8 P.M. and 8 A.M. This timing reflects the fact that people are asleep during much of this 12-hour period; hence, detection is delayed.

The peak of the graph is between the hours of midnight and 2 A.M. These fires are usually caused by people who retire or fall asleep before discovering an incipient fire condition.

Dwellings

There were 46 large loss of life fires in dwellings killing 261 of the 566 persons who died in all the 1960 large loss of life fires. This is 46.1 per cent of the total loss of life deaths. For the purpose of this study one-, and two-family dwellings are included in this "dwelling" category.

The dwellings in which these multiple-death fires occurred ranged from the most modern of the split-level homes, to a single-room shack. The families varied from those of respected hard-working citizens to the local ne'er-do-well. About 80 per cent (210) of the 261 victims were children.

Twenty-seven of the fires occurred in one-story homes, 17 in two-story and 2 in three-story dwellings. Forty-three of the homes were wooden structures; 2 were brick, wood-joist; and one was a metalclad, wood-framed building.

Origin of the Fires in the Dwellings

The majority of the 46 fires started on the ground floor with the living room the leading room of origin. The following table gives the breakdown of the floor and room of origin, the number of fires, and the number of persons killed by these fires.

	Number of Fires	Number Killed By These Fires
Basement	2	10
Ground floor	41	233
Upper floor	2	11
Undetermined	1	7
	46	261
Living room	17	102
Kitchen	13	71
Bedroom	5	27
Bathroom	2	11
Recreation room	2	10
Heater room	1	6
Laundry	1	5
Undetermined	5	29
	46	261

Detection of Dwelling Fires

When occupants are asleep and the fire starts in an unoccupied place in the dwelling, and when there is no warning of the fire until it is so far advanced that smoke or heat awakes the sleepers, then there is little mystery about the cause of the resulting large loss of life. Delayed discovery was a definite factor in 33 of the 46 fires, and 185 of the 261 deaths. In 8 of these fires, deaths occurred when occupants were asleep and the fire originated in one of the *occupied* areas. One fire causing 7 deaths occurred when at least one occupant was awake, but he was *not* in the area of fire origin.

Twelve (12) cases occurred when at least one occupant was awake and in the room where the fire started. In these cases detection was prompt, yet 71 persons died. In these cases flame spread was so rapid that the occupants did not or were not able to escape quickly enough.

In one case, the action of the occupants could not be accurately determined.

Twenty-eight fires were detected by outsiders; 26 of these were by passers-by and 2 by police. These fires caused 157 deaths. The remaining 104 deaths were caused by the 18 fires detected by occupants who in some way gave the alarm.

Location of Persons Killed

Part of the analysis of each dwelling death was to determine where the persons were when the fire started. Seventy-one per cent of the victims were on the first floor of their dwellings. The bedroom was where 82 per cent of the victims first learned of the fire — if they awoke at all. Many died in bed seemingly without distress. Table 1 shows the complete breakdown.

TABLE 1

Location of the Victims When Fire Detected

	All Dwellings (46 fires)		One-story (27 fires)	Multiple-story (19 fires)
	Total Killed	Per Cent of Total	Number Killed	Number Killed
Basement	5	2	—	5
Ground floor	187	71	154	33
Second floor	67	26	—	67
Upper floor	2	1	—	2
	261	100	154	107
Bedroom	214	82	110	104
Living room	31	12	30	1
Kitchen	8	3	8	—
Hall	7	3	6	1
Bathroom	1	0	—	1
	261	100	154	107

Factors Contributing to Death

Each fire was further analyzed to determine the factors which contributed to the death of the victims. Both the primary and secondary factors were recorded and the results are given in Table 2.

One hundred and eleven died because they were already trapped by the time they awoke, 49 were killed when trapped by the rapid spread of fire due to a gas explosion or the misuse of flammable liquids. Thirty-five children died when their parents left them alone in the house, and 30 people were trapped due to rapid flame spread on combustible interior finishes.

Again in 1960, *trapped by fire* was the predominant factor in large loss of life dwelling fire deaths.

The direct cause of death was difficult to determine as many bodies were severely burned. An attempt was made to classify the reason for each death from the medical report where results were reported, or by judgment from the position of the bodies where definitive reports were not available. From this study it is indicated that 168 of the dead were killed by asphyxiation and 93 from massive bodily burns.

Rescue

What rescue there was, was usually carried out by desperate members of the victims' families. Neighbors, in a few cases were able to save someone, but usually by the time they were alerted the buildings were so heavily charged with smoke, if not fire, that there was nothing they could do. In only 2 of the 46 cases was there any possibility of rescue by the fire department. In one case the fire fighters quickly removed the bodies indicating good training and efficient leadership, but the victims were already dead. In the other case the available firemen started on the fire fighting job before rescue. When rescue was finally attempted, only two of those recovered were revived. It is not known whether the others in this fire could have been saved by earlier rescue.

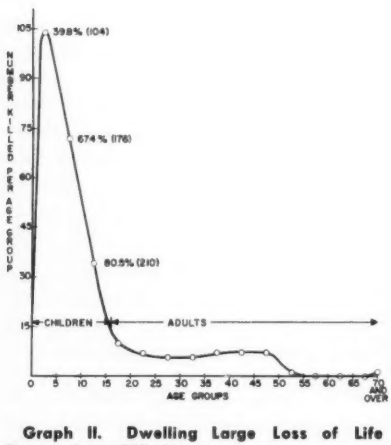
In 41 cases, 233 persons were dead on arrival of the public fire department and the buildings were heavily involved.

TABLE 2

Factors Responsible For Loss of Life in 46 Dwelling Fires

	Primary Factors		Secondary Factors	
	No. Killed	Per Cent	No. Killed	Per Cent
Trapped by fire in dwelling	217	83.2	205	78
Asleep—exits blocked on discovery	111	42.6	22	8.4
Gas explosion or flammable liquid flash fires	49	18.8	6	2.3
Interior finish caused rapid flame spread	30	11.5	50	19.2
Open stairways prevented exit from upper floors	17	6.5	40	15.4
Inadequate exits for area involved	10	3.8	82	31.4
Awake—exits blocked on discovery	0	0	5	1.9
Children left unattended	35	13.4	7	2.
Remained in a burning building	9	3.4	22	8.
To save lives	4	1.5	2	0.7
While father investigated smoke	5	1.9	0	0
Children scared–hid instead of escaping	0	0	20	7.7
Individuals intoxicated	0	0	5	1.
Other factors	0	0	22	8.
Total	261	100.0	261	100.

In 24 fires a delay in giving the alarm after the fire was discovered may have been a factor in 144 deaths. In 3 cases 16 persons died where no fire department was available.



Graph II. Dwelling Large Loss of Life Fires — Age of Victims.

Ages of Victims

Graph II continues to illustrate the tremendous toll these fires take on the young. Four out of every 5 persons who died in a dwelling fire were under 15 years of age. Those under 15 accounted for 80.5 per cent (210) of the fatalities, with those under 4 accounting for an incredible 39.8 per cent (104), or almost 2 out of every 5 persons. Those between 5 and 9 accounted for 27.6 per cent (72) of the deaths and those 10 through 14 for 13.1 per cent (34).

Cause of Fire

Table 3 gives the causes of the large loss of life dwelling fires along with the number killed by fires attributed to these causes. Fires due to defective or overheated heating or cooking equipment again top the list. Almost one-third (85) of the deaths were due to this cause. Twelve of these 14 fires occurred during the 6 months of October to March, an indication of the effect of heating equipment on this record.

TABLE 3

Large Loss of Life Dwelling Fire Deaths by Cause of Fire

	Killed		Fires	
	Number	Per Cent	Number	Per Cent
Heating and cooking equipment	85	32.5	14	30.4
Oil-fired heating equipment	35	13.4	5	10.8
Wood or coal stoves	16	6.1	3	6.5
Flammable liquids used to freshen fire	16	6.1	3	6.5
Gas-fired heating equipment	11	4.2	2	4.4
Defective chimney	7	2.7	1	2.2
Electrical wiring or equipment	29	11.2	5	10.8
Smoking and matches	28	10.7	5	10.8
Flammable liquids	17	6.5	3	6.5
Gasoline stored in house	12	4.6	2	4.4
Defective kerosene lamp	5	1.9	1	2.2
Incendiary (deliberate)	10	3.8	2	4.4
Gas explosions	6	2.3	1	2.2
Rubbish, ignition unknown	6	2.3	1	2.2
Children and matches	5	1.9	1	2.2
Undetermined	75	28.8	14	30.5
Total	261	100.0	46	100.0

Defective wiring and worn-out electrical equipment accounted for 29 deaths; careless smoking, 28. The 5 fires due to smoking occurred in the hours between 11 P.M. and 4 A.M.

Reports of Dwelling Fires

Dwelling of Lionell Scott
near Thompson Falls, Mont., Jan. 9, 2:55 A.M.
6 Killed: All Children

This fire in a 2-story wooden farm house illustrates the speed of fire spreading through a typical North American dwelling and the dangers of delayed discovery.

Eight of the 11 children in this family were asleep when their father awoke to find heavy smoke in the first floor bedroom. He yelled "fire" and attempted to reach the two second floor bedrooms where 6 of his children slept. He found the stairs blocked by fire. He raced outside to get the help of his oldest boy asleep next door.

The mother, also asleep with twin 4-month old babies in the first floor bedroom, was awakened by the father's call. She grabbed each baby by a wrist and tried to get out through a window. She found it blocked. She then tried to crawl under the crib but was unable to. She then headed for the front door. She found the living room and stairway fully ablaze and sped for the back door and safety.

In the short space of time between the time the father raced out and the mother followed the same route, the conditions had deteriorated badly. The father escaped uninjured. The mother and babies were burned but escaped. The six children asleep in the second story never got out.

The fire was presumed to have started from defective electrical wiring as dimming of the lights had been noticed during the evening.

Dwelling of David Blair
Tuckers Corner, N. Y., Feb. 12, 4:00 A.M.
5 Killed: 2 Adults, 3 Children

Smoking in bed was the probable cause of fire that took the lives of an entire family of five. The fire seemed to have originated in the husband's bedroom and had made so much headway when discovered by a neighbor at 4:00 A.M. that the house could not be entered.

Two weeks earlier a mattress fire had occurred in the house when the mother of the family had fallen asleep while smoking.

It appears that the father awoke to find his bedroom in flames. He went either to the bathroom to fetch water or lost his way, for he was found on the bathroom floor. The children were found in their beds and the mother on the springs that had been the living room sofa.

Dwelling of Ronald Salt
Bend, Ore., Feb. 14, 12:03 A.M.
6 Killed: 2 Adults, 4 Children

The Salts lived in a pleasant 2-story home. Mr. Salt worked nights at a service station nearby. On Saturday night, February 13, he went to work about 11 P.M. Finding business slow and the other attendants able to handle things, he went home to get a book. He returned to the station about 11:40 P.M.

The house as he left it had a combustible fiberboard ceiling, and a stairway with the door at the foot blocked open. His daughter and three sons (1½ to 5½ years old) were asleep upstairs and his wife and sister-in-law asleep downstairs. Sometime after Mr. Salt returned to the station a fire of undetermined cause started in the living room and spread rapidly over the combustible interior finish. At 12:03 A.M. a passerby telephoned the alarm to the fire department. Fire fighters knocked the fire down easily but the occupants were already dead.

Mrs. Salt was found upstairs with the baby indicating there was time to get upstairs. Why she did not close the door to the stairway, and why the sister-in-law did not escape are questions that remain unanswered.

Dwelling of Bessie Ruth Miller
near Trussville, Ala., Feb. 25, 7:45 P.M.
5 Killed: All Children

Five children died in this four-room wooden dwelling within 10 minutes of the time their mother went to visit a relative nearby.

The cause of the fire is not clear, but it is known the twin boys, 6 years old, their brother, 4, and sisters, 3 and 5 months, were killed before the blaze was even discovered. The home was fully involved by fire before fire fighters could assist.

Wide World

This February 12 fire took the lives of all members of the David Blair family. Smoking in bed was the reported cause of the fire. Delayed detection while occupants slept was the cause of the deaths.

Dwelling of Luis Juarez
Fillmore, Calif., Mar. 2, 4:37 P.M.
5 Killed: All Children

United Engraving Co.

Left alone in the custody of their older sister, these children were dressed for their naps. The sister left to visit nearby. The children ignited the couch with matches and, terrified, ran back to the bedroom of the 1-story building. Huddled there the children waited for help. The fire in the davenport filled the house with heat and smoke suffocating the children.

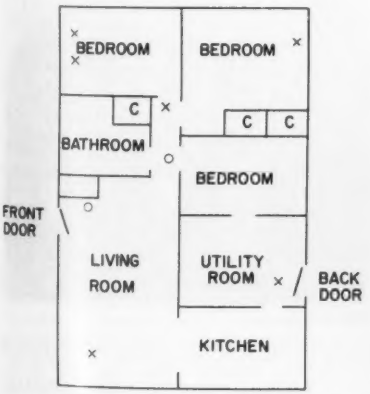
The fire was finally seen by an outsider who telephoned the alarm, but the children were already dead.

Dwelling of Jack Dietsch
near Evansville, Ind., March 4, 10:57 P.M.
6 Killed: All Children

This 1-story, attractive, prefabricated modern ranch house was the scene of the death of 6 children (ages 20 months to 9 years). The fire was reported to have started in the utility room from either a faulty furnace or ignition of lint from a dryer. It spread rapidly over combustible interior finish trapping the occupants.

The children had been instructed that in case of fire they were to gather in a bedroom. This plan had been devised after 2 other children had been killed in a fire in a similar house. As will be noted from the accompanying diagram, this plan was not followed probably because of the extent of fire when discovered. The mother and her 6-year-old daughter were rescued but badly burned.

× FATALITY
○ UNCONSCIOUS, BURNED BUT SURVIVED



Dwelling of Emmett F. McNamara
Bay Shore, N. Y., May 1, 5:10 A.M.
5 Killed: 3 Adults, 2 Children

A fire of undetermined origin started in a newly built first-story recreation room of this all-wood dwelling about an hour after the last person used the room. Knotty pine walls in the recreation area had been varnished and waxed and flames spread rapidly through it to involve all of the 3-story structure. Although 6 of the 10 occupants were rescued, one of them, a 7-year-old boy, died the following day.

The alarm was telephoned to the fire department by a neighbor who first heard "crackling" of flames and then saw them.

Dwelling of Lelus Faison
Richmond, Calif., July 10, 3:28 A.M.
6 Killed: 2 Adults, 4 Children

Lives of 4 children and 2 adults were snuffed out during an early morning fire originating in and confined to the kitchen adjacent to bedrooms in a 1-story wooden home. Fire first involved a cardboard box used for discarded cooking oils, soap and grease, spreading then to nearby papers,

Fire Marshal

Drennan Photos, Inc.

An early-morning May 1, fire in a glassed-in porch recreation room spread into this old but well maintained dwelling and spread up the open stairway. Flames killed 5 of the ten occupants. Three survivors escaped by themselves and two were rescued by the first patrolman on the scene.

trash and garbage. The blaze is believed to have started spontaneously or to have been caused by carelessly discarded smoking materials. Doors between rooms were open, and toxic fire gases spread quickly.

When the husband returned home from work he found the house fully charged with smoke. He was successful in removing three of the victims before fire fighters arrived. Resuscitation was unsuccessful.

Dwelling of Mary Dustin
Buffalo, N. Y., Oct. 12, 4:48 A.M.
5 Killed: 1 Adult, 4 Children

The family living in the second story and attic of a 2-family, 2½-story all-wood dwelling had moved in only two days before fire occurred. Careless disposal of smoking materials in the second-story bathroom is believed to have started fire, alarm for which was given by police at 4:48 A.M. Occupants of the first floor apartment and neighbors attempted to rescue those trapped on the upper floors without sending someone to notify the fire department, and it is estimated that there was a 20-minute delay between the time of discovery and the time the alarm was received.

All of the victims slept on the second floor. Two boys (17 and 15 years old), who were

Buffalo Evening News

asleep in the attic, awoke to find themselves trapped by smoke. They jumped to the ground and were seriously injured in the leap.

Dwelling of Audrey Nitzband
Appleton, Wisc., Oct. 14, 10:08 A.M.
6 Killed: 1 Adult, 5 Children

Appleton Post Crescent

It appears that one of the children turned on the LP-Gas fired oven of the stove in this three-room home. The unignited gas filled the oven and spread into the kitchen. Then the gas ignited from an unknown source.

The explosion shoved one wall of the dwelling out of line and killed an adult and 3 children instantly. Two other children lived for several hours in the hospital before succumbing.

Dwelling of Ray McWilliams
Parkersburg, W. Va., Oct. 25, 1:15 A.M.
6 Killed: 1 Adult, 5 Children

An ordinary hot water tank was being heated in this dwelling by a gas burner installed under it. The tank and burner were located in the bathroom. Five children were asleep in a rear bedroom when fire, originating near the hot water tank in the adjacent bathroom, aroused one, a 6-year-old girl. She tried to awaken the other children without success and then ran screaming into the living room, at which time her cries aroused the parents sleeping in the front bedroom with 2 other children.

The father led 2 children to safety and returned to rescue his wife and the 5 other children, but was driven back by flames at both the front and rear doors as was a neighbor who tried to aid him. Other neighbors, aroused by the commotion, summoned the fire department. Upon their arrival, fire fighters tried to rescue those trapped, but by this time the building was entirely engulfed in flames and efforts were futile.

Fire spread rapidly through the 1-story, all-wood dwelling, fed by combustible ceiling board and cardboard walls.

Dwelling of Robert Stevenson
Pilesgrove Twp., N. J. Nov. 6, 10:10 P.M.
5 Killed: 1 Adult, 4 Children

Lives of a mother and four children were lost in a fire originating in the kitchen of their 2-story wooden home. Flames had engulfed almost the entire 24 foot by 35 foot structure when discovered by a neighbor who turned in the alarm from the nearest telephone one-quarter mile away. Three children (16, 8, and 7), who had been sleeping in first-floor bedrooms, escaped by this time. One child (5 years old) who slept on the first floor and 3 children and their mother who slept upstairs could not get out.

The location of the fire had to be relayed to the fire station by telephone from a funeral home where the alarm was received and the town alarm sounded. Relay of the fire's location to volunteer firemen arriving at the station was hampered by the large number of calls to the funeral home by curious citizens inquiring about the alarm, thus tying up the telephone.

Cause of the blaze was believed to have been sparks from a wood fire in a kitchen stove, used also for heating the house.

Dwelling of Bernard Carpenter
Cleveland, Miss., Nov. 7, 10:45 P.M.
5 Killed: 2 Adults, 3 Children

Ten days after their $20,000 colonial home was remodeled, the Carpenter family was killed by a small evening fire in their home.

The fire originated, after the family had retired, in the new all-electric kitchen near the built-in oven. The fire generated smoke which spread throughout the house, but the heat and fire damage was confined to the kitchen.

The positions of the bodies indicated that the family awoke in time to get out of bed but not in time to open the windows since they were found under the windows.

The fire was discovered when alert police officers traced the odor of smoke in the area to the Carpenter home, but too late to save life.

Dwelling of Paul A. LaPrise
Ashland, Mass., Nov. 10, 1:07 A.M.
5 Killed: 2 Adults, 3 Children

An entire family was killed and their 2-story, $18,000 home severely damaged when an early morning fire broke out in the living room. Apparently a cigarette ignited a couch on which the mother was dozing while watching television in the living room. The mother was awakened by the fire and was able to reach the foot of the open stairway before being overcome.

The open stairway to the second floor permitted the fire gases generated to enter the bedrooms where the husband and 3 children slept. The fire was not discovered until a passing motorist saw flames shooting from the front windows. Fire fighters were able to knock the fire down and recover the bodies within 15 minutes of arrival, but the victims were dead before the alarm sounded.

Dwelling of Levite Landry
Monneault's Mills, N. B., Nov. 22, 11:00 A.M.
5 Killed: All Children

The mother, 28, left five pre-school children (ages 4, 3, 2, 1, and 2 months) of her 10 children alone when she went to visit a neighbor. Four children were playing in the kitchen and the baby was in its crib when she left. What happened is not known but a neighbor discovered smoke coming from the house and called the fire department. Flames spread throughout the structure before any rescue could be attempted. The 4 children's bodies were found in the bedroom with the baby, all huddled in a blanket where they had hidden from the fire.

Dwelling of Robert Powell
Wicomoco, Md., Dec. 2, 2:45 A.M.
7 Killed: 2 Adults, 5 Children

Ten persons were saved from the second story of this wooden farm dwelling when the 21-year-old daughter threw her brothers and sisters from the second-story window of this dwelling.

An overheated chimney ignited the first floor of the building killing the mother, father and 5 children sleeping on this floor. None died on the second floor due to the oldest sister's prompt action. Injuries to those rescued were minor in nature.

Dwelling of Dr. C. H. Young
New Orleans, La., Dec. 15, 5:20 A.M.
6 Killed: 1 Adult, 5 Children

A person smoking in bed in a first-story bedroom apparently started fire in the 2-story wooden dwelling. Flames spread rapidly to the upper floor where the mother and all of her children were trapped in a second-floor bedroom and asphyxiated before fire fighters arrived in response to a neighbor's telephoned alarm. Fire officials indicate that the victims were unable to get out of the second-story because the only escape route was the narrow stairway which was blocked by flames.

Dwelling of Abel Vosburg
Noyan, P. Q., Dec. 29, 2:00 A.M.
12 Killed: 3 Adults, 9 Children

United Press International

A crude 15 foot by 20 foot corrugated iron-clad, wood-framed dwelling contained a mother, father and 11 of their 15 children, (ranging in age from 6 months to 19 years). The other children were married or working away from home. The father alone escaped an early morning fire that was at first thought to have been accidental. Evidence after the funeral, however, raised doubts and the bodies were exhumed. Autopsy results indicate that the mother had died violently before the blaze. It is now thought that she was murdered and that her body and the 11 children were deliberately burned to cover up the crime.

Wide World

A twenty-one year old girl saved ten children by throwing them out the second floor window of this Wicomoco, Md., dwelling. Seven died on the first floor.

Apartments and Rooming Houses

Apartment House
Wichita, Kans., Feb. 6, 6:56 P.M.
6 Killed: 1 Adult, 5 Children

Wichita Eagle

Two men brought automobile transmission parts into the second-story kitchen, poured gasoline into a dish pan on the floor and started cleaning the parts. Fifteen minutes later gasoline vapors that had spread throughout the second story ignited. A gas-fired water heater was the probable ignition source. One man, his clothes aflame, raced into the living room where he died. The other grabbed his wife and dived through a living room window. Another woman (a visitor) grabbed one of her children and dived out another window. Those four people were the only survivors. The remaining 5 children burned to death.

Rooming House
Harrisonburg, Va., Feb. 22, 3:53 A.M.
5 Killed: 3 Adults, 2 Children

Fire which started in the first floor closet beneath stairs to the second story was of suspicious origin. It was discovered at 3:53 A.M. by an occupant after burning for an undetermined period in the 2-story brick, wood-joisted building. Smoke spread easily up the open stairway to the upper floor. Four of the deaths occurred in the upper story. In addition to the victims, 9 persons were seriously injured after jumping from second-story windows.

Apartment House
Omaha, Nebr., May 28, 4:04 A.M.
7 Killed: 1 Adult, 6 Children

Twenty-five persons occupied 8 apartments in this building. Five persons lived on the first floor, 8 on the second, and 12 on the third.

Dan Mulcahey

One adult and six children died in this May 28, apartment house fire in Omaha, Nebraska.

The fire was discovered by an occupant about 4:00 A.M. and the alarm was promptly transmitted. Flames had spread from the first floor apartment of origin to the hallway. Smoke and heat were rising up the stairway from which the doors had been removed. The fire department aided in rescue of all occupants but the 7 who died on the third floor. The fire was caused by smoking.

Hotel Fires

St. James Hotel
Omaha, Nebr., Feb. 23, 1:29 A.M.
9 Killed: All Men

This 3-story cut-rate hotel accommodated mainly old men. Someone deliberately used a kerosene-type flammable liquid to light a fire in the second-floor washroom of the hotel. The fire burned through the substandard stairway enclosure trapping eight men on the third floor. The rear stairway was enclosed with wallboard over 2 by 4 studs and a wood panel door sheathed with asbestos millboard — not asbestos cement board.

One man died of injuries sustained as he dived, in flames, out the window onto the street.

The two exterior fire escapes on one side of the building were evidently not accessible to the victims.

Colonial Inn
Bristol, R. I., July 10, 6:00 A.M.
6 Killed: 2 Females, 4 Males

Delayed discovery, delayed alarm and absence of automatic sprinklers allowed fire to gain such headway that it could not be controlled promptly by manual means. These factors and inadequate or blocked escape routes resulted in death of the hotel operator, her son and 4 residents of the 3-story, 21-bedroom, 156-year-old, mostly brick-walled residence hotel.

The first floor bar-lounge occupied by a private party until about 4:45 A.M., is believed to be the area where fire started. It is reported that the telephoned alarm by neighbors was delayed over 10 minutes. Fire fighters, arriving in response to the 6:00 A.M. alarm, found the building heavily charged with smoke, and flames pouring from both ends of the first floor.

Open stairways permitted unchecked vertical extension of fire to charge upper floor halls with smoke and flame before sleeping occupants were aware of the fire. One third floor occupant, a volunteer fireman, was awakened by the town fire siren and was driven back to his room as he attempted to enter the hall. He and two others, including a man who went out a bedroom window to the roof of the rear 1-story dining hall, were rescued over fire department ladders.

John S. Savage

The St. James Hotel, scene of the death of nine elderly patrons. The February 23 arson fire occurred in Omaha, Nebraska.

One victim was found in the rear hallway of a second story "L" apparently overcome by smoke as he attempted to reach a rear window. There were no fire escapes on this part of the structure. The son of the proprietress succeeded in breaking his bedroom window before being overcome and falling back into the room. The other 4 persons were suffocated in their rooms, 3 while still in bed and one while trying to reach the door.

The exit conditions at this hotel were quite substandard. The fire escapes were either blocked by nailed sash and screens or located outside the window of a locked room. There were no exit signs, emergency lights, or stairway enclosures.

Even though the stairway should have been equipped with a door at each floor, it is doubtful that this would have kept the smoke off upper floors as it was driven up the nonfirestopped walls into the upper floors and attic of the old building. It is certain that had the building been equipped with a complete automatic sprinkler system, properly maintained, the fire would have been controlled in an early stage, the alarm given and the persons evacuated, possibly under smoky conditions but with no loss of life.

Four 2½-inch, 6 1½-inch and 2 high pressure booster lines were needed to bring the fire under control and to protect exposed property, after a 1¾-hour battle. Although cause of the fire has not been determined definitely, authorities are holding a man on manslaughter charges who confessed to accidentally setting it in the bar-lounge.

Bristol Phoenix Photo

The difficulty of rescue during a well-developed fire is shown by this unusual photograph of the July 10 fire in Bristol, R. I.

TABLE 4A

1960 Large Loss of Life Residential Fires and Explosions Killing 5 or More Persons

Date	DWELLINGS Location	Total Killed	No. Children 0-14
Jan. 6	Girard Twp. P. Q.	7	6
Jan. 9	Thompson Falls, Mont.	6	6
Jan. 24	Tompkinsville, Ky.	6	6
Jan. 24	Manning, S. C.	6	2
Jan. 30	Sunnyville, N. S.	6	5
Feb. 12	Tuckers Corner, N. Y.	5	3
Feb. 14	Bend, Oreg.	6	4
Feb. 16	Midway, Ga.	5	5
Feb. 18	Chattanooga, Tenn.	5	4
Feb. 21	Oberlin, Ohio	7	7
Feb. 25	near Trussville, Ala.	5	5
Feb. 27	Campbellford, Ont.	5	4
Mar. 2	Fillmore, Calif.	5	5
Mar. 4	near Evansville, Ind.	6	6
Mar. 5	Powhatan, Va.	5	4
Mar. 17	Franklin Square, N. Y.	5	4
Mar. 27	near Winthrop, Me.	6	4
Apr. 1	Lynnhaven, Va.	6	4
May 1	Bay Shore, L. I., N. Y.	5	2
May 22	New Glasgow, N. S.	6	6
July 10	Richmond, Calif.	6	4
July 22	near Hawthorne, Calif.	7	5
Aug. 5	Shirley, W. Va.	5	4
Sept. 30	Corvis Twp., Mich.	5	3
Oct. 2	near Vicksburg, Miss.	5	4
Oct. 12	Buffalo, N. Y.	5	4
Oct. 14	Thicket Portage, Man.	5	3
Oct. 14	Appleton, Wisc.	6	5
Oct. 25	Parkersburg, W. Va.	6	5
Nov. 6	Uno, Ark.	5	3
Nov. 6	Pilesgrove, N. J.	5	4
Nov. 7	Cleveland, Miss.	5	3
Nov. 10	Ashland, Mass.	5	3
Nov. 11	Jackson, Miss.	5	5
Nov. 11	Corpus Christi, Texas	5	5
Nov. 15	St. Antoine de L'ile Aux Grues, P. Q.	5	4
Nov. 21	De Funiak Springs, Fla.	5	5
Nov. 22	Owenton, Va.	5	5
Nov. 22	Monneault's Mills, N.B.	5	3
Dec. 2	Wicomoco, Md.	7	5
Dec. 13	Wertzville, Pa.	7	6
Dec. 15	New Orleans, La.	6	5
Dec. 22	Chicago, Ill.	5	4
Dec. 22	Hartford City, Ind.	6	5
Dec. 25	Langhorne, Pa.	5	5
Dec. 29	Noyan, P. Q.	12	8
	APARTMENTS		
Feb. 6	Wichita, Kan.	6	5
Mar. 20	Philadelphia, Pa.	5	3
May 28	Omaha, Neb.	7	6
Nov. 10	Chicago, Ill.	5	2
Dec. 29	Cleveland, Ohio	5	5
	HOTELS		
Feb. 23	Omaha, Neb.	9	0
July 10	Bristol, R. I.	6	0
	ROOMING HOUSES		
Feb. 22	Harrisonburg, Va.	5	2

TABLE 4B

1960 Residential Fires and Explosions Killing 4 Persons

Date	DWELLINGS Location	Total Killed	No. Children 0-14
Jan. 1	Copper Cliff, Ont.	4	1
Jan. 21	El Dorado, Ark.	4	4
Feb. 16	Rome, N. Y.	4	2
Feb. 16	Wellersburg, Pa.	4	?
Feb. 17	Hilltop, W. Va.	4	?
Feb. 21	Bluff Springs, Fla.	4	3
Feb. 21	near Wharton, Texas	4	4
Feb. 22	near Statesville, N. C.	4	2
Mar. 9	near Columbia, Mo.	4	4
Mar. 14	near Norfolk, Va.	4	4
Mar. 20	Tokio, N. D.	4	3
Mar. 24	Conshohocken, Pa.	4	4
Mar. 26	Rankin, Pa.	4	4
Mar. 30	Grand Forks, N. Dak.	4	2
Apr. 3	Smithtown, L. I., N. Y.	4	3
Apr. 19	Omaha, Nebr.	4	4
May 2	Nu Mine, Pa.	4	3
June 19	Petersburgh, Alaska	4	?

DWELLINGS

Date	Location	Total Killed	No. Children 0-14
June 23	Perris, Calif.	4	3
June 30	Centralia, Wash.	4	3
July 7	Gravesville, N. Y.	4	2
Aug. 22	Baltimore, Md.	4	2
Aug. 24	Detroit, Mich.	4	3
Oct. 7	Portland, Oreg.	4	3
Oct. 29	Dayton, Ind.	4	3
Nov. 5	Cleveland, Ohio	4	4
Nov. 5	Rotterdam, N. Y.	4	4
Nov. 7	near Lansdowne, Ont.	4	3
Nov. 8	Haverhill, Mass.	4	3
Nov. 10	Cleveland, Ohio	4	4
Dec. 1	Birmingham, Ala.	4	4
Dec. 2	Huntington, Pa.	4	4
Dec. 3	Cleveland, N. Y.	4	4
Dec. 4	Byron Center, Mich.	4	4
Dec. 5	Lafleche, P. Q.	4	4
Dec. 9	Burlington, Vt.	4	3
Dec. 9	Quilchena, B. C.	4	4
Dec. 12	Madison Heights, Va.	4	4
Dec. 22	Poteet, Texas	4	4
Dec. 23	Minari, Ont.	4	4
Dec. 24	near Brantford, Ont.	4	4
Dec. 31	Los Lunas, N. Mex.	4	4

APARTMENTS

Date	Location	Total Killed
Jan. 9	Chicago, Ill.	4
Feb. 7	Brooklyn, N. Y.	4
Feb. 14	Fort Worth, Texas	4
Apr. 10	Birmingham, Ala.	4
Apr. 21	Winnipeg, Man.	4
July 4	Sterling, Ill.	4
Sept. 4	Boston, Mass.	4
Nov. 14	Muskegon, Mich.	4
Nov. 23	Canastota, N. Y.	4
Nov. 25	Pittsburgh, Pa.	4
Dec. 13	Kenosha, Wisc.	4

HOTELS

May 28	Algona, Iowa	4
June 12	Gary, Ind.	4

MOTELS

Sept. 14	Houston, Texas	4

ROOMING HOUSES

June 6	Vancouver, B. C.	4

Total Killed	No. Children 0-14
4	4
4	?
4	0
4	0
4	2
4	1
4	3
4	3
4	4
4	2
4	4
4	0
4	0
4	2
4	2

1960 Large Loss of Life Fires —

In Transportation Equipment

There were 16 large loss of life fires, killing *five* or more persons, connected with transportation during 1960 in the U. S. None occurred in Canada. These fires resulted in the deaths of 172 persons. Last year 146 persons died in 14 fires causing 6 or more deaths. The number of incidents and deaths by mode of transportation follows:

	Number of Fires	Number Killed
Aircraft	12	98
Automobile	1	5
Ships	2	55
Train	1	14
	16	172

Again this year the largest loss of life for the year occurred in this group. On December 19, in New York City the carrier "Constellation" burned killing 50 workmen (see page 259). This and other 1960 large loss of life transportation fires are reported herein.

Aircraft Fires

There were 12 large loss of life aircraft accidents where five or more lives were lost as a result of fire aboard aircraft in flight or where the fire following crash was judged, from the information available, to be the primary cause of the fatalities. A total of 98 persons lost their lives in these accidents. Seven of these accidents where 6 or more died by fire are briefly reported here and all the cases are listed in Table 5A on page 257.

U. S. Air Force Aircraft
Ramey Air Force Base, Puerto Rico, Feb. 1
7 Killed

Transition "touch and go" landings were being made during crew training exercises. A B-52G with a crew of 7 had completed several landings without incident, but after taking off from the last one at about 10:50 P.M., the 8 engine jet fell off sharply to the right after gaining about 1,000 feet of altitude. The right wing contacted the ground first in a playground of the housing area of the Air Base. The aircraft exploded almost instantly and fuel, spread over a large area, ignited in a large flash fire. The aircraft had about 85,000 pounds of JP-4 fuel aboard at the time of the accident.

Crash crews on standby duty during the training exercise responded immediately on observing the crash and gave the alarm to the crash station for other equipment. The wreckage was strewn over a large area of the playground and adjacent portions of the airfield. Fortunately only two houses were in the path of the wreckage and no ground fatalities resulted.

Crash apparatus used in the rescue and fire control attempts included five Type O-11A's aided by three pumpers and a tank truck manned by 67 fire fighters. Fog-foam was used to eliminate spot fires burning in the crash area and water to cool the hot metal to save as much of the wreckage as possible for investigation purposes. Six of the bodies were found on the burned flight deck; the seventh had been thrown clear of the fuselage. Actual fire fighting requirements were less than normal because of the big cloud of fuel mist vapors that flashed at impact but did not burn in substantial pools or in the wreckage.

U. S. Air Force Aircraft
Walker Air Force Base, New Mexico, Feb. 3
9 Killed

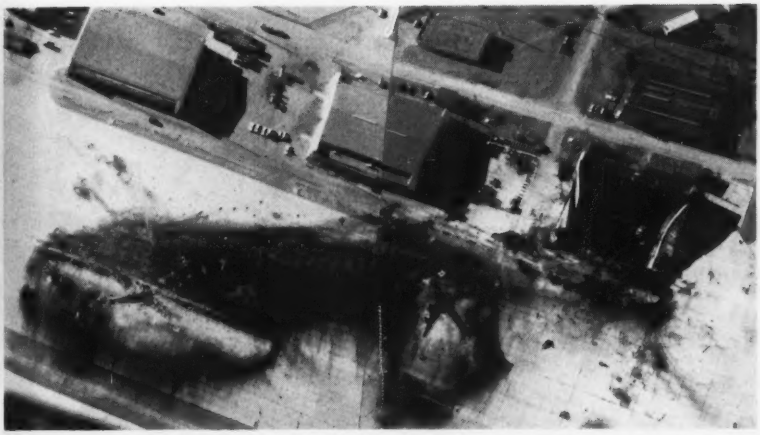
Loss of control during take-off resulted in a KC-135 crashing into two parked KC-135 aircraft on the ramp of this New Mexico Air Base followed by collision with a hangar building. Fire destroyed all 3 of the aircraft involved, one hangar and 14 parked cars. The loss is estimated at $21,400,000. The 5 crew members aboard the fuel-laden tanker plane died in the crash and 4 occupants of the hangar were killed.

The aircraft left the runway during take-off, but apparently could not be controlled

The remains of one of the KC-135's which was parked on the ramp and struck by the runaway aircraft.

The hangar which was destroyed by the crash. Four mechanics in the hangar were killed, as well as all five crewmen on the tanker plane.

The extent of the flame front down the ramp at the Walker Air Force Base following the crash of a KC-135 into two other parked aircraft and a hangar building on Feb. 3, 1960. The pictures above show other scenes during this $21,400,000 fire.



A composite photo of the ramp and hangar area involved at Walker AFB.

by the pilot, resulting in the left wing striking the ground and the aircraft swerving to the ramp area where it struck two parked jet tankers. These KC-135's are basically the same aircraft as the Boeing 707 civil transports but designed to carry fuel for airborne fueling operations rather than passengers. It is estimated that as a result of this accident some 54,400 gallons of JP-4 fuel were spilled and ignited. The ramp drainage system was thus filled with fuel. Intermittent flaming occurred at ramp drain inlets as fuel vapors mixed with air and were ignited and a major fire developed at the ramp drain outlet. The ramp drainage system, however, did not figure significantly in the method of fire control or in the extent of the loss sustained. However, it was necessary to commit fire fighting manpower and equipment to flush fuel from the system and to guard drain inlets for surveillance purposes.

The bulk of the fire fighting was directed at protection of exposures to prevent fire spread due to the immediate intensity of the fire situation. Wind direction and velocity (27 to 34 knots) was a major problem in achieving fire control and in preventing a conflagration on the flight line. Besides the terrific heat and dense smoke, aircraft and vehicle debris made maneuvering of fire equipment on the ramp most difficult. Air base fire equipment (including 5 major crash units, 2 water tankers and 4 pumpers) manned by a total of 80 firemen (76 military, 4 civilian) fought the blaze. The City of Roswell, New Mexico dispatched 2 pumpers, one remaining at the Air Base fire station as cover-in and the other was operated with Air Base equipment. In all, some 242,000 gallons of water were used in the fire fighting attack plus 750 gallons of mechanical foam concentrate, 1,000 pounds of chemical foam powder and 4,100 pounds of low pressure carbon dioxide. It was felt by the Air Base that if the pumpers had the capability of metering foam this would have permitted a more progressive attack on the fire.

U. S. Navy Aircraft
over Puget Sound, Washington, Feb. 11
9 Killed

A rocket assembly being carried by a P5M seaplane exploded while the aircraft was airborne and located about 11 miles from the Whidbey Island Naval Air Station. The aircraft plunged into Puget Sound carrying all 9 crew members aboard to their deaths.

The rocket assembly exploded while the aircraft was making a rocket firing run on a target towed in the water. A witness on the target tow-boat saw the rocket fire normally but almost immediately it exploded under the wing. Wreckage of the P5M recovered revealed shrapnel-like metal from the rocket assembly had cut the main spar of the wing causing it to be severed. None of the rocket assembly was recovered for possible examination.

The crash was witnessed from the carrier "Shangri-La." The twin-engine "Marlin" rolled to the left and flames erupted behind and below it before it began its fatal plunge.

Chicago Helicopter Airways
near Maywood, Illinois, July 27
13 Killed

The 11 passengers and 2 crew members aboard a Chicago Helicopter Airways S-58 died when it crashed into a cemetery in Forest Park, Illinois about 10:37 P.M. Witnesses reported that the helicopter lost one of its main rotor blades and a portion of its tail assembly prior to striking the ground and burning.

The aircraft was being used in a shuttle service between Midway Airport on the southwest side of Chicago and O'Hare International Airport on the northwest side. The main fuselage contained 9 bodies and the tail section with 4 victims was found 900 feet away. In-flight structural failure of one of the main rotor blades, which was found 3000 feet from the fuselage, is thought to have been the cause of the accident. Eight of the 13 persons suffered major burns. Fire companies from several suburban departments responded to telephone, box and radio alarms from persons living near the scene and from another helicopter pilot, but arrived too late to effect any rescues.

U. S. Air Force Aircraft
near Langley Air Force Base, Va., Oct. 18
7 Killed

During a transition training exercise, involving executing take-offs and full-stop landings, the crew of a KB50-J was making the fifth take-off in what appeared to the tower to be a normal manner. The aircraft's flight path after take-off was over water and for unexplained reasons it struck the water about 2 miles from the end of the runway in shallow water approximately 1,000 feet from the shore of a marshy peninsular. The aircraft exploded upon impact and all 7 crew members sustained fatal injuries.

Arctic Pacific, Inc., Aircraft
Toledo Express Airport, Toledo, Ohio, Oct. 29
22 Killed

The most tragic aircraft fire accident of the year occurring in the United States in which the majority of deaths are directly attributable to the fire aspects occurred at Toledo on October 29.

(Editor's Note: The mid-air collision occurring over New York with 134 deaths was, of course, the worst aviation disaster in history but it cannot be established with certainty how many of the victims died from impact injuries as opposed to the resultant fires, except for the 6 people who were killed on Brooklyn streets by the fires which resulted there. Overseas, a number of serious aircraft flight and crash fires occurred, the worst occurring in Guam involving a World Airways DC-6A killing 74 of the 90 aboard, the majority of the victims being trapped by the flames.)

Wide World Photo

The unburned tail section of the C-46 which crashed in Toledo on Oct. 29. Twenty-two died in the tragic crash.

The Toledo accident occurred during take-off of the chartered C-46 in a heavy fog. The victims, including 16 members of the California State Polytechnic College football team, the pilot and co-pilot and 4 others, were mostly burned to death in the front section of the twin-engine aircraft according of a medical examiner. The tail section broke off at impact and most of the survivors were in this section, many suffering severe injuries and burns. From the information available to date, it would appear that the flight was operated, in the words of FAA Administrator Quesada, with "a gross disregard for public safety and the regulations of the Federal Aviation Agency." The Airlines operating license was suspended within two days of the crash under the emergency suspension authority of the FAA.

Newspaper accounts indicate that the aircraft sustained a power failure during take-off and crashed just after having become airborne (maximum altitude about 100 feet), alongside the 7,000-foot main runway of the Airport. The fog was so dense that the control tower operator could not see the flames only from about 400 yards away. Air National Guard personnel, having a

Wide World

Where the DC-8 crashed in Brooklyn. Church destroyed is in the right foreground. Six persons on the ground were killed as well as all the occupants of the jet.

Halloween party in a nearby hangar, grabbed extinguishers and rushed to the scene. The volunteer Airport and Air National Guard Fire Departments responded. These departments have 4 major units of fire equipment (a pumper with a 500 gallon water tank, a high pressure water fog unit with a 350 gallon water tank, and 2 USAF-ANG Type 0-10 crash trucks) and a Dodge rescue truck. Outside assistance is available from the Crissey Fire Department. There was a delay of about three minutes in the response of rescue and fire apparatus because of the fog. The principal fire control effort was with water fog and fog-foam, but it is not established whether any of the 26 who escaped with their lives can thank these fire crews for their rescue. It is hoped to develop further information after the investigation is completed.

United Air Lines and Trans World Airlines Aircraft over New York, New York, Dec. 16
6 Killed (134 Total)

Six of the 134 lives lost because of this mid-air collision between a United Air Lines DC-8 and a Trans World Airlines Constellation are recorded here as "fire deaths." Undoubtedly many other victims died as a result of the fires which ensued following the airborne collision, but the NFPA has no autopsy data by which to evaluate the number of occupants of the two aircraft who died of burns and suffocation as opposed to impact injuries. Both aircraft did catch fire in flight according to eye witnesses.

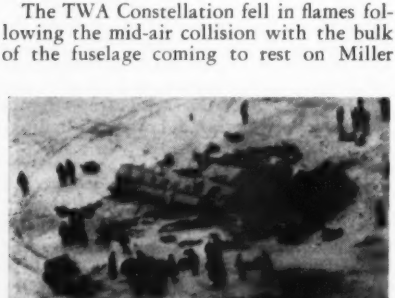
The six persons recorded as definite fire victims were those on the streets in Brooklyn where the DC-8 crashed. That the death toll there could have been much worse is evident from the fact that just down the street a block or so were schools housing a total of about 1,700 children at the time of the accident (10:34 A.M.). Another amazing fact is that while 25 cars on Seventh Avenue and Sterling Place were demolished by the impact and subsequent fires, only one person was killed in a car, the others being unoccupied at the moment disaster struck! Frightened occupants of the apartment buildings, damaged and ignited by the falling

aircraft, fled to the street following the initial blast. Fire department rescue teams were amazed not to find trapped victims in these buildings.

It appears that the main ground blast and fire which resulted from the crash of the DC-8 in Brooklyn centered in the ironically named "Pillar of Fire" Church. This building was reduced to a mass of rubble with the destruction indicating that an explosion of considerable force occurred within the stone, brick and wood-joist structure. Theorizing on the type of damage to this building and what happened elsewhere in the area, leads one to imagine that much of the fuel in the DC-8 cascaded from the shattered wings into the church, was atomized and literally exploded. Most of the other structures in the area were apartment houses and combined apartment and commercial buildings. Some of these were damaged by falling parts and about 10 were ignited by the ensuing crash fire but none were so absolutely reduced to rubble as was the Church.

Only one of the 84 occupants of the DC-8 was found alive — an 11-year-old boy who was thrown from the plane and landed in a snowbank with his clothing on fire. The boy lived only until the next day despite desperate attempts to save his life by his rescuers and the personnel at a Brooklyn hospital. One report indicates that the child died of damage to his lungs from inhalation of the flames which had also caused third degree body burns.

The TWA Constellation fell in flames following the mid-air collision with the bulk of the fuselage coming to rest on Miller Field (an Army landing field) in New Dorp Staten Island. One of the jet engines of th DC-8 also fell to earth on Staten Island This was the first positive clue that there had been a mid-air collision and not two separate and simultaneous accidents. Al the 44 occupants of this plane died but for tune was even more kind there as no one o the ground was injured, the falling parts narrowly missing the thickly populated single-home area bordering the field. Three of the passengers in the tail section of th Constellation were alive as first rescuers reached the scene, but all succumbed soon afterwards, either en route to or in a local hospital. One of those found alive was gravely injured by burns as his clothing had been ignited. An Army Lieutenant, who raced to the scene from a hangar about a mile from the crash site, extinguished the burning clothing and initiated rescue operations.



Wide World

The TWA crash site on Staten Island.

Fire control and rescue efforts in the Brooklyn crash sites gave New York firemen one of their toughest assignments. All the evidence points to effective work and the disaster control activities of both the Police and Fire Departments are praiseworthy. At the Brooklyn scene more than 250 firemen and about 50 pieces of apparatus responded to the scene and in a little more than two hours the fires were under control. The first alarm in the Brooklyn area was rung in at 10:36 A.M. with seven alarms being sounded to bring additional masses of fire fighters and equipment to the scene. The tail assembly of the DC-8 landed ablaze at the intersection of Seventh Avenue and Sterling Place while the nose and engines of the jet were buried in the wreckage of the church. The slope of Sterling Place permitted burning fuel (kerosene grade) to flow down under parked cars resulting in a number of fuel tank explosions in these vehicles. Flames issuing from the wreckage and the burning buildings concealed, for a time, the exact identity of the aircraft involved. A number of heroic rescues by neighbors assisting others from burning portions of the four-story "brownstone" apartments were reported in press accounts.

On Staten Island, the blazing forward section of the Constellation landed less than 150 feet from the nearest home bordering Miller Field while a 30-foot wing section landed 50 feet from a row of frame officers' quarters on the field. An engine fell in a school playground. About 100 firemen responded to this crash site and used foam and water to extinguish the fires in the fuselage

and tail sections. This was made less difficult by the fact that the aircraft came apart in the air. The three major sections that fell on Miller Field were: (1) the forward section of the fuselage where most of the bodies were recovered (victims burned beyond recognition in some cases), (2) the rear section of the fuselage and the tail assembly (the three passengers, 2 men and a woman were pulled alive from this section) and (3) the right wing and outboard engine. The rest of the aircraft was strewn over the airfield and in the bay and at least one body was found ¼ mile from the fuselage.

An intensive investigation is under way to determine the cause of the collision. Obviously air traffic control efforts failed to keep the two aircraft, one headed for LaGuardia from Dayton and the other headed for Idlewild (N. Y. International) from Chicago, from a collision course, but determining who or what was responsible for the disaster is not nearly as important as finding the cures for more effective traffic control in the increasingly crowded air space, particularly in the proximity of airports.

TABLE 5A

1960 U. S. Large Loss of Life Aircraft Fire Accidents Killing 5 or More Persons

Date	Place	Type Aircraft	Ownership	No. Killed On Board	No. Killed On Ground
Feb. 1	Ramey Air Force Base, Puerto Rico	B-52G	U. S. Air Force	7	0
Feb. 3	Walker Air Force Base, New Mexico	3 KC-135's	U. S. Air Force	5	4
Feb. 11	Puget Sound, Washington	P5M	U. S. Navy	9	0
Mar. 27	Fort Sill, Okla.	H-37	U. S. Army	5	0
Mar. 31	Little Rock, Ark.	B-47	U. S. Air Force	3	2
Apr. 24	near Columbus, Ohio	Unknown type	Private	2	3
May 3	Ramey Air Force Base, Puerto Rico	C-46	Brazilian ownership	5	0
July 28	Maywood, Ill.	S-58	Chicago Helicopter Airways	13	0
Oct. 18	near Langley Air Force Base, Va.	KB50-J	U. S. Air Force	7	0
Oct. 29	Toledo, Ohio	C-46	Arctic Pacific, Inc.	22	0
Nov. 8	Lockbourne Air Force Base Ohio	B-47	U. S. Air Force	5	0
Dec. 16	Brooklyn and Staten Island, New York	DC-8 and Constellation	United Air Lines & Trans World Airlines	*	6
Total				83	15

*128 passengers aboard the two planes which collided in flight also lost their lives.

TABLE 5B

Other 1960 Serious Loss of Life Aircraft Fire Accidents Killing 4 Persons

Date	Place	Type Aircraft	Ownership	No. Killed On Board	No. Killed On Ground
Feb. 14	near Clarkson, Mich.	Unknown type	Private	4	0
May 23	Atlanta, Georgia	880	Delta Air Lines	4	0
June 7	Patuxent Naval Air Station, Md.	F8-U and Helicopter	U. S. Navy and U. S. Air Force	4	0
July 4	Shattuck, Okla.	Beechcraft	Private	4	0
Aug. 28	near Tupelo, Mississippi	Unknown type	Private	4	0

TABLE 6

Other 1960 U. S. Large Loss of Life Aircraft Accidents

Date	Place	Ownership	Type Aircraft	No. Kille
Jan. 6	near Bolivia, N. C.	National Airlines	DC-6B	34
	Dynamite explosion within passenger cabin, burned on impact			
Jan. 18	near Holdcraft, Va.	Capital Airlines	Viscount	50
	Power loss in flight, vertical descent, burned on impact			
Mar. 17	near Tell City, Ind.	Northwest Airlines	Electra	63
	Structural failure in flight, vertical descent, burned on impact			
Apr. 18	near Harmon Air Force Base	USAF	C-124	9
	Power-on collision with hillside, burned on impact			
Apr. 20	Hickory, N. C.	Private Plane & Piedmont Airlines	Cessna 310 and F-27	4
	Collision in flight, Cessna crashed; F-27 landed successfully.			
July 20	near Dalzell, S. C.	USAF	2 RF 101's	4
	In-flight collision, aircraft crashed and burned			
Oct. 4	Boston, Mass.	Eastern Airlines	Electra	62
	Power failure on take off, crashed in harbor waters, no fire			
Oct. 28	near Frenchtown, Montana	Northwest Airlines	DC-4	12
	Crashed into mountain, burned on impact			
Dec. 21	Off Newfoundland	U. S. Navy	P2V	9
	Crashed into ocean during fleet exercise, no fire			

TABLE 7

1960 Major Aircraft Disasters in Other Countries

Date	Place	Operator	Type Aircraft	Type Accident	No. Kille
Jan. 19	near Ankara, Turkey	Scandinavian Airlines System	Caravelle	CF	41
Jan. 19	Taurus Mountains, Turkey	U. S. Navy	PFM	CF	16
Jan. 21	Montego Bay, Jamaica	Avianca	Constellation	CF	37
Feb. 5	near Cochabamba, Bolivia	Lloyd Aereo Boliviano	DC-4	FF	55
Feb. 25	near Rio de Janeiro, Brazil	U. S. Navy & Real S. A.	DC-6 & DC-3	None	61
Feb. 26	nr. Shannon Airport, Ireland	Alitalia	DC-7C	CF	30
Apr. 19	Bogotá Int. Airport, Colombia	Lloyd Aereo Colombiano	C-46	CF	33
June 24	Brazil	Brazilian Airliner	Unknown	NR	35
July 14	Philippine Sea	Northwest Airlines	DC-7C	FF	1
July 16	Copenhagen, Denmark	Zonerednings-korpset	D.H.89A	None	8
July 20	near Goma, Congo	Belgian AF	C 119	CF	34
Aug. 29	near Dakar, Senegal	Air France	Constellation	CF	63
Sept. 7	near Salto, Uruguay	Argentine Airlines	DC-6	FF	31
Sept. 19	Mt. Barrigada, Guam	World Airways	DC-6A	CF	74
Sept. 26	near Trukovo, USSR	Austrian National Airlines	Viscount	CF	30
Nov. 7	near Quito, Ecuador	Ecuatoriana Aereo	F-27	CF	37
Nov. 23	Mount Baco Philippines	Philippine Airlines	DC-3	CF	33
Dec. 9	Amazon Jungle, Brazil	Brazilian Airliner	Unknown	NR	15
Dec. 17	Munich, Germany	USAF	C-131	CF	52
Dec. 21	Cebu, Philippines	Philippine Air Lines	DC-3	CF	28

CF = Crash Fire; FF = Flight Fire; NR = Not Reported

Other U. S. Aircraft Disasters

A number of other major loss of life aircraft accidents occurred in the United States during the year but these lives are not charged to fire, where fire did occur, for the reasons given in the listing after each reference in Table 6.

Overseas Aircraft Disasters

Table 7 lists the major 1960 foreign aircraft disasters with an indication where fire did occur and the type of fire. This list is probably not complete but is a record of those incidents of which the NFPA has knowledge.

Ships

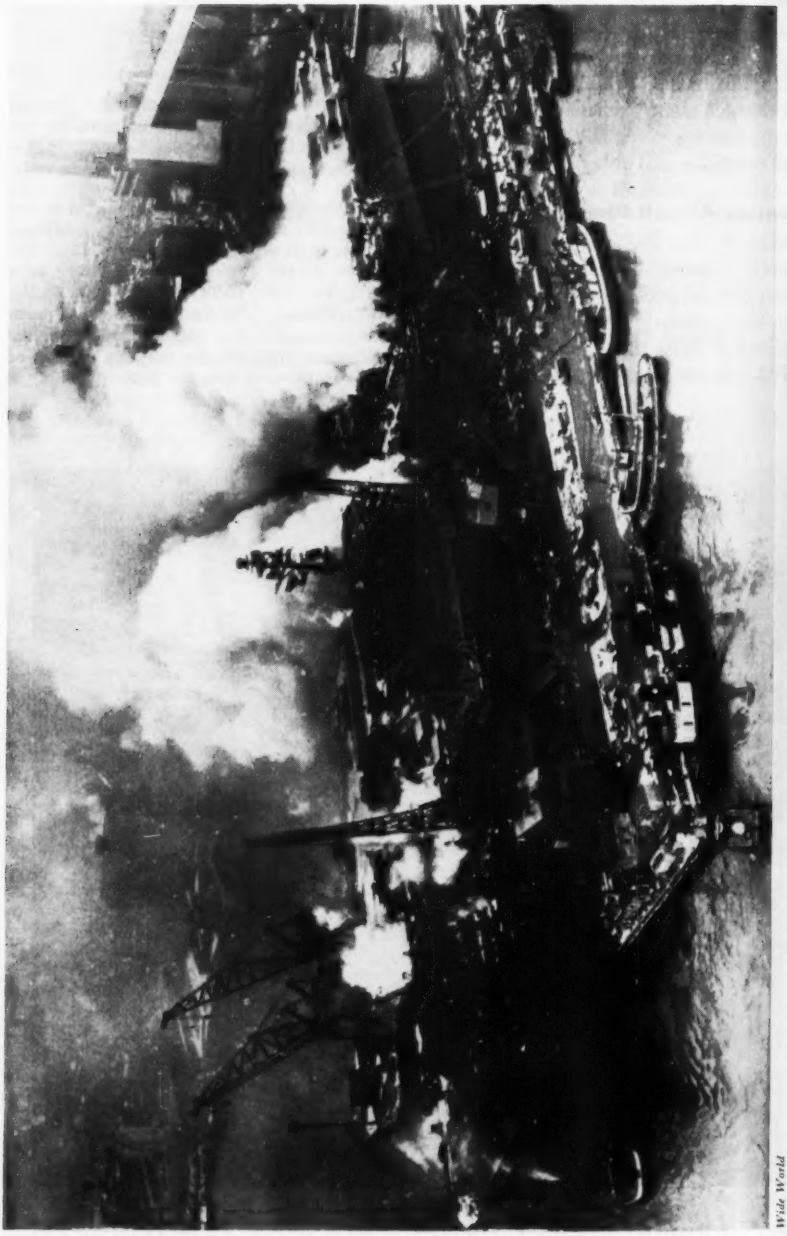
Super Carrier "Constellation"
New York, N. Y., Dec. 19, 10:30 A.M.
50 Killed: All Adults

A lift truck hit a steel plate which sheared a brass valve from a diesel fuel tank on the hangar deck of this super carrier under construction.

Five hundred gallons of fuel spilled to the deck and flowed down a bomb elevator shaft and through work holes in the deck. The vapors ignited from a welding torch at a lower level, and flames flashed back to the hangar deck. The fire spread to wooden construction shacks, wooden scaffold planks and spread through the midship section of the hangar deck and on the three decks above.

Wide World

The temporary combustible "suspended ceiling" shown on the hangar deck of the "Constellation" contributed to the intensity of the fire in this area.

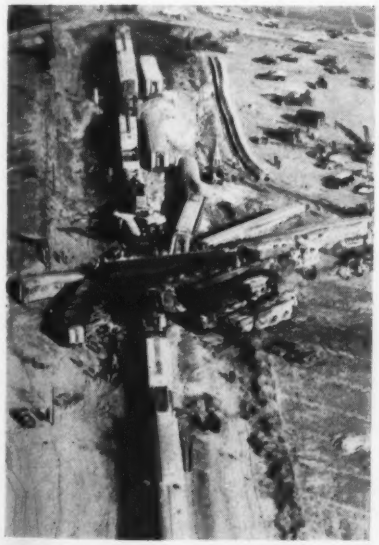


Smoke and heat trapped some of the 3300–3500 workers on the vessel and 50 were killed. A preliminary report has been published in the January issue of *Fire News* and a complete report is scheduled to follow.

Train

Santa Fe Railroad Train and Oglesby Tank Truck near Bakersfield, Calif., March 1, 5:15 P.M. 14 Killed

A tank full-trailer unit hauling 7500 gallons of crude oil and the crack passenger train "San Francisco Chief" collided at a grade crossing and fire immediately involved the diesel engine locomotives. The truck driver, locomotive engineer and fireman, and 11 train passengers were killed and 63 passengers injured. The relative responsibility of collision impact and fire in claiming the 14 lives was not established.



Wide World

Fourteen lost their lives in the fire which followed this grade crossing accident involving an oil truck and a passenger train.

TABLE 8A

1960 Auto, Ship and Train Fires and Explosions Killing 5 or More Persons

(For aircraft accidents see Tables 5A, 5B, 6 and 7)

		No. Killed
Automobile		
Nov. 20	near Pikeville, Ky. Automobile left road and burned	5
Ships		
Aug. 13	off Georgia Coast at sea, Minesweeper "Exultant"	5
Dec. 19	New York, N. Y. Carrier "Constellation"	50
Train		
March 1	near Bakersfield, Calif. "San Francisco Chief" and crude oil tank truck	14

TABLE 8B

1960 Truck and Train Fire Accidents Killing 4 Persons

		No. Killed
Trucks		
Sept. 19	near Carbondale, Pa. Truck out of control — hit house, both burned	4
Nov. 11	near Brinkley, Ark. Pick-up truck backed into gasoline tank — burned	4
Trains		
June 10	Jacksonville, Fla. Freight train and gasoline tank truck	4
Aug. 8	Birmingham, Ala. Freight train and fuel oil tank truck	4

Wide World

The carrier "Constellation" is programmed to have manually operated deluge sprinkler protection installed but this fire struck first.

Brownfield News, Brownfield, Tex.

Scene of a grain dust explosion which killed six employees at Brownfield, Texas. One victim was rescued by an Army helicopter from the top of the elevator.

1960 Large Loss of Life Fires —

In Industrial Properties

Four industrial fires and explosions, each responsible for *five* or more deaths, occurred in the U. S. and Canada in 1960, killing 32 men.

The largest was the October 4 explosion at Kingsport, Tennessee, at the Tennessee Eastman Company. This explosion took 15 lives.

Goodpasture Grain and Milling Co., Inc
Brownfield, Tex., July 19, 4:58 P.M.
6 Killed

While turning milo, which consisted of transfering the grain from the bottom of one tank to the top of another, two almost simultaneous explosions occurred in the elevator and tank sections of the 4,112,000 bushel capacity terminal elevator. The first explosion is believed to have originated in an elevator leg which, in turn, initiated a more severe explosion in the separate elevator storage section. It is believed that the blast from the first incident traveled through the conveyer tunnel to the empty east grain bin where the second explosion occurred.

All 6 employees working at the time were killed, 4 almost instantly with 2 dying after removal to the hospital. One of the victims who escaped had jumped 50 feet from the top of the elevator and another was rescued from it by a U. S. Air Force helicopter. A former steeplejack volunteered to "ride" the rescue rope hanging from the aircraft.

Although there was comparatively little ensuing fire, damage is estimated at $750,000.

Wilmington Fire Dept.

A plastic dust explosion killed five at this Wilmington, Del. plant.

Tennessee Eastman Company
Kingsport, Tenn., Oct. 4, 4:45 P.M.
15 Killed: All Adults

A remotely controlled aniline process on the company's grounds was destroyed by a detonation resulting from a hitherto unknown chemical reaction. The process equipment contained nitric acid, mononitrobenzene and water which detonated in the equipment. Fifteen men were killed and over 60 persons injured.

Dow Chemical Company
Freeport, Texas, Oct. 24, 10:30 A.M.
6 Killed

The corroded walls of an evaporator ruptured releasing a boiling mixture of allyl chloride and propylene chloride. The hot vapors exploded. Flying pieces of metal and flames injured 15 workers and killed 4 others. Two of the injured died later.

Synvar Corporation
Wilmington, Del., Nov. 8, 11:45 A.M.
5 Killed

When an employee operated a switch for a densifier on the first floor of the molding compound department of this synthetic resin manufacturer a light explosion occurred. This explosion raised dust from rafters, ledges, and machinery throughout the area. The first explosion served as an ignition source for the large dust cloud thus raised. The secondary explosion that followed was large enough to wreck the plant, kill 4 men, and injure 5 others critically — one of the injured subsequently died.

Nonexplosion-proof electrical equipment and dust accumulation on structural members and elsewhere violated the "Code for the Prevention of Dust Explosions in the Plastics Industry," NFPA No. 654.

TABLE 9A

1960 Industrial Fires and Explosions Killing 5 or More Persons

Date	Location	No. Killed
July 19	Brownfield, Tex. Goodpasture Grain & Milling Co., Inc.	6
Oct. 4	Kingsport, Tenn. Tennessee Eastman Company	15
Oct. 24	Freeport, Texas Dow Chemical Co.	6
Nov. 8	Wilmington, Del. Synvar Corp.	5

TABLE 9B

1960 Industrial Fires and Explosions Killing 4 Persons

Date	Location	No. Killed
March 3	East Chicago, Ind. Sinclair Refining Co.	4
Aug. 15	Houston, Texas Rheem Mfg. Co.	4

Wide World

An explosion of flammable vapors that escaped from a corroded evaporator killed six men at Freeport, Tex., Oct. 24.

1960 Large Loss of Life Fires —

In Mercantile Properties

Four fires and explosions in mercantile properties in the U. S. and Canada, each killing *five* or more persons, occurred during 1960. In these fires, 22 civilians and 8 fire fighters died. The two largest mercantile losses occurred on July 18 and on October 25. Both were due to gas explosions, both killed 10 persons, and both occurred in department stores. There were no large loss of life mercantile fires in 1959.

Chez Charlebois
Montreal, P. Q., Mar. 2, 5:30 A.M.
5 Killed: All Firemen

A roof collapse during a 5:30 A.M. fire in this ½ acre 3-story wooden building trapped and killed 5 fire fighters who had been on the roof. The fire started in the rear of the first floor, spread throughout the entire building and damaged nearby stores and dwellings.

Calso Filling Station
Auburn, N. Y, Mar. 30, 7:50 P.M.
5 Killed: 3 Firemen and 2 Other Adults

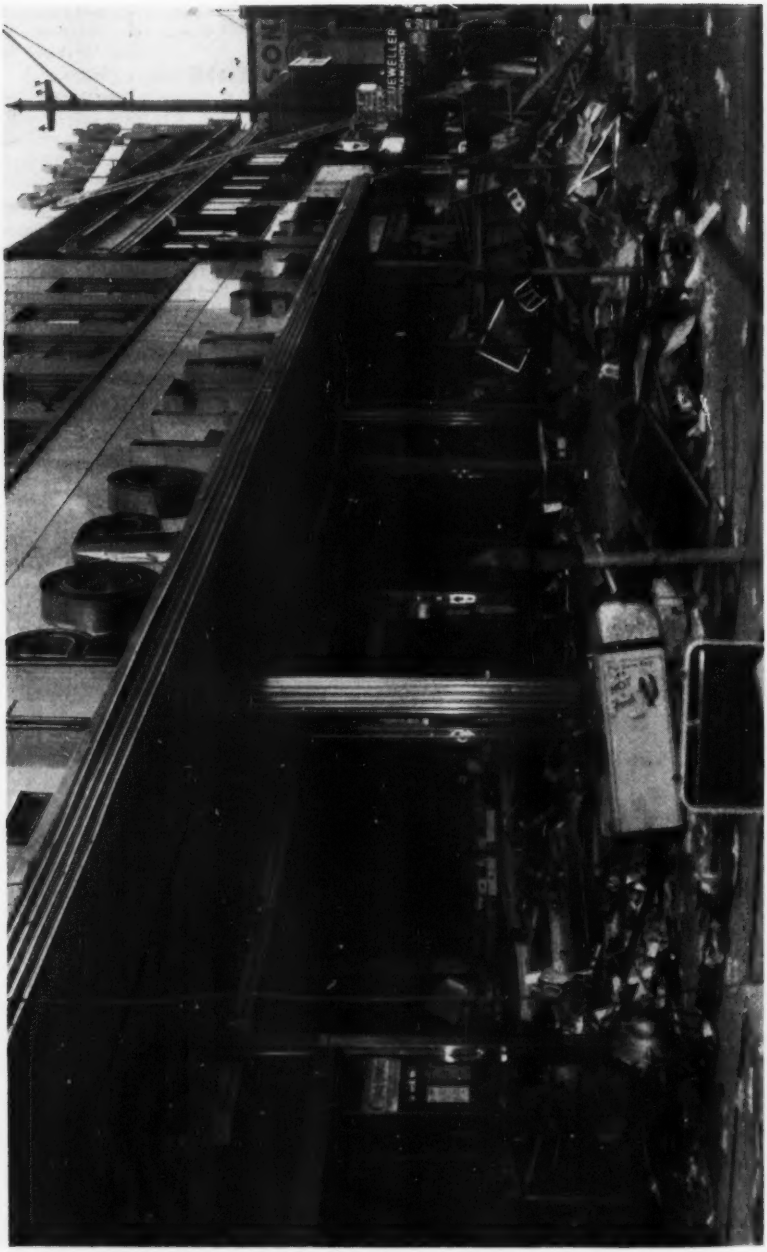
Following a telephone call from the filling station operator reporting presence of gasoline vapors, the fire department sent one engine with an officer and 3 men to investigate. A hose line had been laid and gasoline accumulations were being flushed away when a violent explosion occurred. Three fire fighters and 2 civilians in the station were killed by the blast. The source of ignition was not determined. The source of the gasoline may have been from an abandoned tank which still contained gasoline.

J. C. Penney Company
Merrill, Wis., July 18, 2:05 P.M.
10 Killed: 9 Adults, 1 Child

In addition to the 5 customers and 5 employees killed, 10 others were seriously injured when a gas explosion demolished the mostly 1-story and basement, 50-foot by 120-foot department store. The masonry

A. G. Tarby

Wreckage of a gasoline filling station in Auburn, N. Y. which killed five.



Windsor Star

A basement gas-air mixture caused this explosion damage at Windsor, Ont. while 150 persons were in the store.

Jim Freiberg

Ten persons lost their lives when a gas-air mixture in the building collapsed the roof. Nine years earlier a former building on the same site in Merrill, Wisconsin was also wrecked by a gas explosion.

walls were blown outward by the blast and the wood-joisted roof fell to the first floor, trapping people in the basement. Fire, which broke out in about 3 to 4 minutes, was controlled within an hour.

The former building on the same site had been destroyed in 1951 by a gas explosion that was caused when a gas pipe inside the building was broken by a swinging door. After that incident, the end of the lateral supply pipe from the 3-inch distribution main in an alley at the rear of the store was capped about two feet from the basement wall. Even though there was no gas service to the department store, propane gas leaking from the underground main is believed to have entered and accumulated in the basement of the building. It is believed that one or more lateral supply lines were damaged during grading of a nearby parking lot located in an area where a dwelling had been razed, thus causing the leaks.

Metropolitan Stores, Ltd.
Windsor, Ont., Oct. 25, 2:12 P.M.
10 Killed: All Adults

At the completion of conversion of a coal-fired heating boiler to a gas-fired boiler, piping to the burners was purged of air. During this procedure gas escaped and formed a flammable mixture with the air in the basement. The mixture ignited explosively, blowing out the back wall of the 2-story brick, bar-joisted building which allowed the rear part of the building to collapse. Ten of the approximately 150 customers and employees in the store were killed. About 75 were injured.

TABLE 10A

1960 Mercantile Fires and Explosions Killing 5 or More Persons

Date	Location	No. Killed
March 2	Montreal, P. Q. Chez Charlebois, Women's Hats	5
March 30	Auburn, N. Y. Calso, Gasoline Service Station	5
July 18	Merrill, Wis. J. C. Penney, Department Store	10
Oct. 25	Windsor, Ont. Metropolitan Stores, Ltd., Department Store	10

TABLE 10B

1960 Mercantile Fire - 4 Killed

Date	Location	No. Killed
March 5	Quebec City, P. Q. Store	4

A basement gas-air mixture caused this explosion damage at Windsor, Ont. while 150 persons were in the store.

Windsor Star

1960 Large Loss of Life Fires —

Other Fatal Fires

Two other large loss of life fires occurred in the U. S. and Canada during the calendar year 1960 which were responsible for *five* or more deaths in each case. Both were underground fires, one of which killed 18.

Coal Mine

Island Creek Coal Co.
Logan, W. Va., March 8, 8:30 A.M.
18 Killed: All Adults

A slate fall is believed to have broken a trolley wire in the mine and resulting arcing started a fire in the coal, probably first involving supporting timbers. A telephone call for help alerted rescuers and described the situation. The trapped miners were cut off from the shaft by toxic gases produced by the fire. Two of the miners were directed by a safety engineer in the trapped group to try to escape through neglected tunnels paralleling the fire area and they barely got out after crawling a distance equal to three city blocks on their stomachs. After more than a week's rescue operations those trapped were reached, but all had been killed by asphyxiation.

Tunnel

Harrop Construction Co.
North York Twp., Ont., Mar. 17, 5:58 P.M.
5 Killed: All Adults

A 36-inch water main was being constructed in a tunnel under the Don River.

Sparks from a welding operation in the compressed air atmosphere of the tunnel ignited a combustible 2½-inch rubber hose. The fire spread to rubber-covered cables. Confusion followed. The two welders escaped after finding nothing available with which to fight the fire. Six men were cut off from the only way out by the smoke and flames. One man hugging the floor was able to survive for several hours after which he crawled out. The remaining five men (ages 45, 27, 25, 23 and 23) died of "acute poisoning by carbon monoxide and suffocation due to the inhalation of smoke, sand and water."

The Coroner's Jury Verdict and Recommendations contained the following statement, "According to the evidence presented, almost all the safety regulations governing this tunnel project were violated at one time or another, and many of the regulations were violated continuously. The attitude of the management towards the safety of the individual worker can be described as no less than callous. Many of the workmen, both on the surface and underground, were inexperienced, untrained or unqualified for the work to which they were assigned. Several of the foremen were not sufficiently competent to be entrusted with the instruction or direction of the workmen. It was evident that most foremen were uninformed of the Department of Labour regulations governing safety requirements."

TABLE 11A

Other 1960 Fires Killing 5 or More Persons

Date	Location	No. Killed
	Coal Mine	
March 8	Logan, W. Va. Island Creek Coal Co.	18
	Tunnel	
March 17	North York, Ont. Harrop Construction Co.	5

TABLE 11B

Other Fires and Explosions in 1960 Killing 4 Persons

Date	Location	No. Killed
	Cafe	
Dec. 24	Charlestown, Mass. Diamond Nugget Cafe	4
	Barn	
Aug. 21	Fowlerville, Mich. Private Barn	4

Acetylene Transmission Systems

Hazardous Properties of Acetylene

Acetylene gas has a flammable range of from about 2.5 per cent to about 81 per cent in air at atmospheric pressure. Acetylene-air mixtures above the upper flammable limit (81 per cent) can decompose explosively when under pressure. In the decomposition reaction the acetylene is converted to hydrogen and carbon. When under pressure *pure* acetylene is also subject to explosive decomposition. Although the decomposition can occur at pressures below 15 psig, this pressure is generally accepted as a safe upper limit for handling acetylene in small diameter piping. In large diameter piping, at atmospheric pressure or below, acetylene may detonate if subjected to extreme shock. The packed-tower flame arrester discussed in the accompanying article is designed to stop the propagation of detonations through pipelines.

Under certain conditions acetylene forms spontaneously explosive compounds with copper, silver or mercury. With copper, for example, highly sensitive copper acetylide is formed.

The large-scale use of acetylene for production of chemicals has created a need for a guide covering the safe handling of this raw material in transmission piping systems.

Recognizing this need, the Scope of Activities Committee of the International Acetylene Association established, several years ago, a Chemical Acetylene Transmission Committee composed of members having considerable experience in this field. The Committee has recently issued its report giving the minimum recommendations for safe operation. Copies of the complete report are available from the International Acetylene Association, 270 Park Avenue, New York 17, price $2.00 each.*

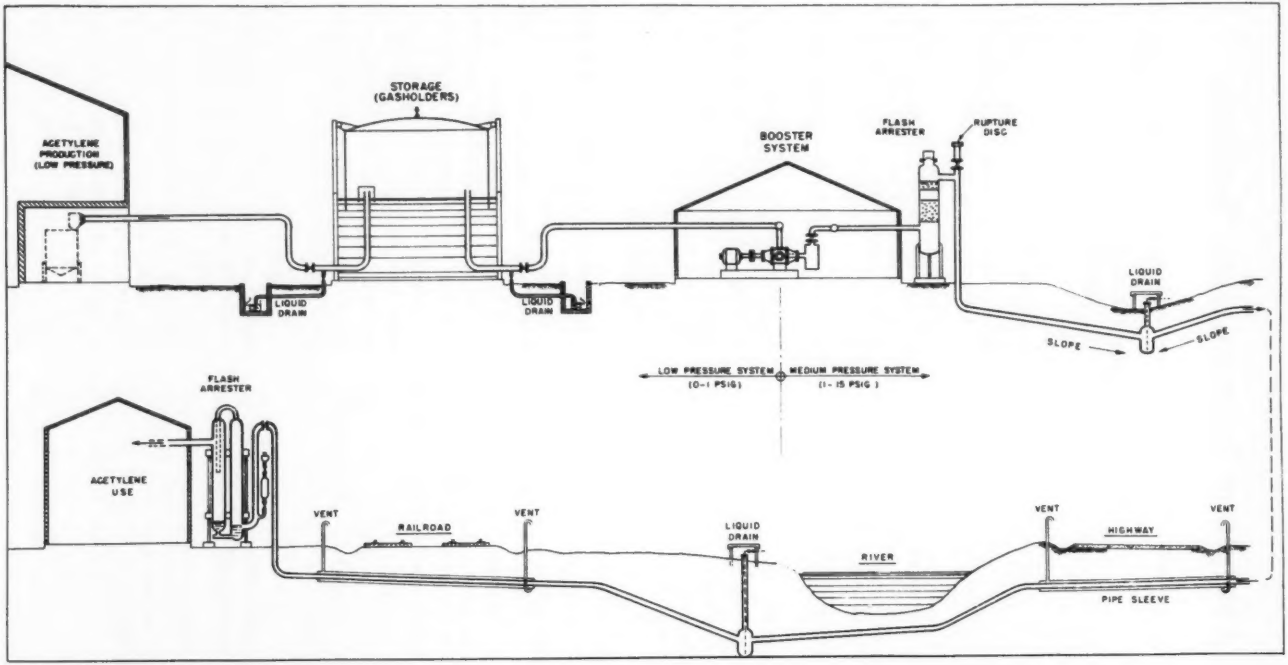
Believing that readers of the QUARTERLY are interested in the subject matter, a brief digest of the IAA recommendations follows. The NFPA Committee on Gases has not reviewed this text and its publication here does not imply any official NFPA action on the recommendations presented.

Safeguards Covered by IAA Report

Primary consideration is given in the report to those properties peculiar to acetylene requiring special handling techniques and protective measures. In addition to the safeguards required by the unstable nature of acetylene, construction and operation of a safe transmission system call for the observation of design precautions that apply to handling flammable gases.

The report confines itself to safety aspects of transmitting acetylene between the source of production and the use point. When the pressure at the source is less than one pound per square inch gage (psig), the distance of transmission to the use point may make it necessary to increase the pressure with the aid of a booster system, such as the pump in Sketch A. When acetylene is produced at medium pressure (1 to 15

*By issuing this report, the International Acetylene Association and its members make no guarantee of results and assume no liability in connection with the information or safety suggestion contained therein. It should not be assumed that every acceptable safety procedure is included, or that unusual circumstances may not require additional precautions. The recommendations should not be confused with state, municipal or insurance requirements that may apply.



Sketch A. Typical low pressure acetylene transmission system. No attempt has been made to show all necessary valves.

psig), the gasholder and the booster system would probably be eliminated, as indicated in Sketch B. Higher pressures are discussed in some instances; however, such systems are outside the scope of this report.

The acetylene to be transported is assumed to be of commercial quality, containing the small amounts of impurities normally present when produced from calcium carbide and hydrocarbon processes. Handling mixtures of acetylene with diluents is also outside the scope of the report.

Some General Rules

All piping and equipment should be grounded and bonded electrically to prevent accumulation of static electricity. Resistance to ground should not exceed 1 ohm and should be checked annually. In locations subject to freezing, when the gas is water saturated, cold-weather protection is recommended for all vessel parts, valves and piping subject to accumulation of water.

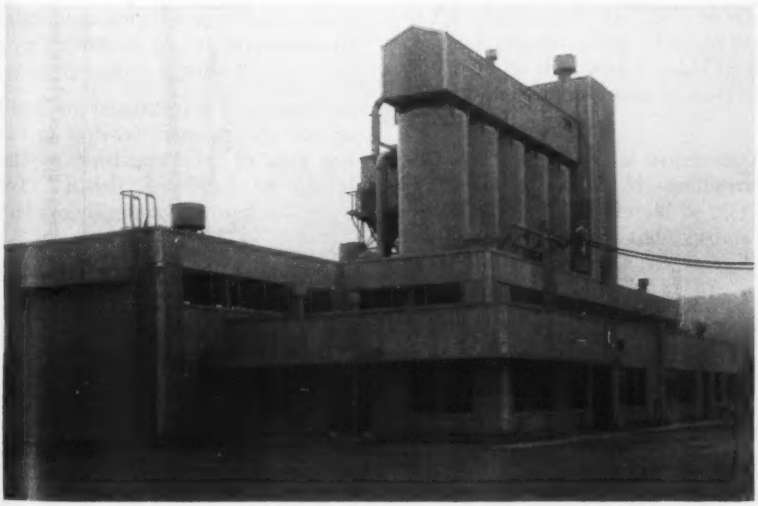
Design and installation of piping systems should provide protection from localized overheating to temperatures above those encountered from atmospheric exposure.

Periodic patrolling of the system should be made a part of the operating procedure, with particular attention to corrosion, leaks, liquid drains and abnormal conditions. Lubrication and cleaning should be on a routine schedule established through operating experience. Protective devices should be tested, inspected and replaced at intervals calculated to guard against fatigue or corrosion.

Proximity Safeguards

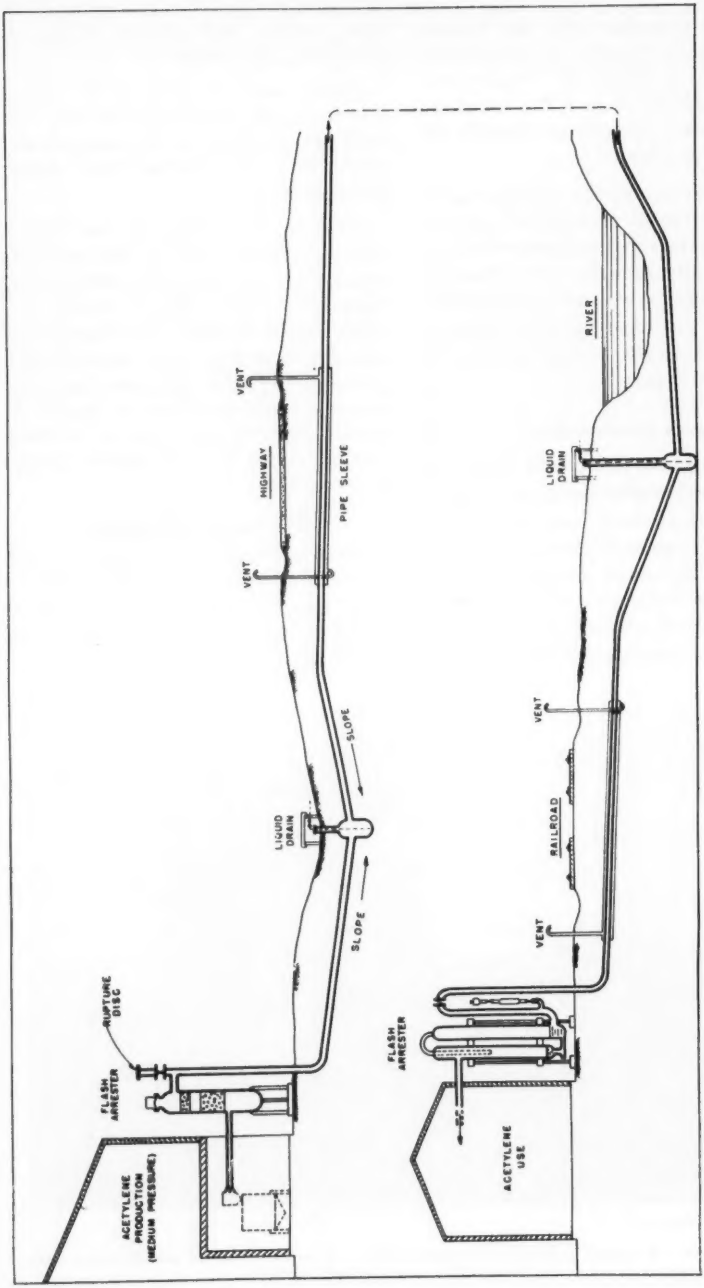
Main acetylene transmission lines should not be run closer than 50 feet to buildings, fire-protection reservoirs, or storage tanks that contain hazardous or flammable liquids.

Sketch A. Typical low pressure acetylene transmission system. No attempt has been made to show all necessary valves.



Union Carbide Olefins Co.

Photo 1. A typical acetylene generating plant. From this location acetylene is transferred by pipeline to a nearby chemical synthesis plant.



Sketch B. Typical medium pressure acetylene transmission system. No attempt has been made to show all necessary valves.

Union Carbide Olefins Co.

Photo 2. A typical acetylene generating plant. Inside view showing arrangement of generators.

Increased clearances should be provided at locations that are considered to be fire or explosion hazards. Avoid installing acetylene lines in the midst of other lines which may require maintenance in which high-temperature or heavy equipment is involved.

When the transmission line comes to a road or railroad crossing, the design should be consistent with locality and layout. Either overhead or underground crossings may be used.

In underground crossings, consider the minimum entrance and exit distances from edges of the crossing, depth of fill over sleeve, location of sleeve vents and type of seal for the sleeve.

Draining and Purging of Lines

Provisions should be made to drain accumulated liquid from the transmission line. Special provisions should be made in the design to prevent entry of air into the line and to prevent freezing of any seal liquid used.

Some way of purging all acetylene lines with inert gas must be provided. Permanent purging lines may be connected to the transmission line, but the connection should be made through two valves in series and a small bleed valve.

Purge systems should be protected against backflow from acetylene lines. There should be no dead-end sections in the acetylene line that cannot be purged positively. All purge connections should be designed to avoid pulling air into the system, located to prevent accumulation of condensate and designed to prevent an accidental connection of any system other than purge gas.

Transmission Line Specifications

Piping

Piping materials of construction should meet the latest requirements of the American Standards Association (ASA), American Society of Testing Materials (ASTM), American Society of Mechanical Engineers (ASME), American Petroleum Institute (API) or other recognized organizations. Design pressure should be that which could be developed by a decomposition of acetylene in the line.

Physical and chemical requirements and tests equal to ASTM specification A-53, A-106 or A-120 should be met in selecting the type, grade and schedule of pipe used in the system.*

Up to and including 6-inch pipes, ASTM A-120, Schedule 40 welded pipes have been found to be satisfactory by repeated detonation tests in a medium-pressure system. For 8-, 10-, and 12-inch pipe, ASTM A-106, Grade B, Schedule 60 pipe can be specifically recommended

*For details, see the Code for Pressure Piping (ASA B31-1) available from American Society of Mechanical Engineers, 29 W. 39th St., New York 18, N. Y.

on the basis of satisfactory performance in detonation tests in a medium-pressure system.

Pipe Fittings and Flanges

Screwed fittings may be used in up to and including 3-inch pipe. Banded malleable iron fittings meeting ASTM A-197 are satisfactory.* Cast-iron fittings and semi-steels should be excluded wherever possible.

Where nipples, couplings and half-couplings are used for attachments, they should be Schedule 80 and designed for 3,000 psi.

Cast-steel flanged fittings or forged-steel welding fittings may be used in all pipe sizes. ASTM A-234 and A-181 are recommended for forged welding fittings and flanges, ASTM A-216, Grade WCB for cast-steel flanged fittings.* Flanged, 150-pound, 6-inch cast-steel fittings with raised faces of ASTM A-216, Grade WCB, successfully passed detonation tests in a medium-pressure system. Similar tests were also satisfactorily conducted on 150-pound, 6-inch and 300-pound, 12-inch flanged welding neck and slip-on flanges with raised faces, ASTM A-181.

Blind flanges fabricated from welding neck or slip-on flanges, as specified above, were found to be satisfactory in detonation tests on a 6-inch pipeline.

Valves, Packing and Gaskets

Flanged or welding-neck valves are generally recommended for lines over 2 inches in diameter. Conventional plug, gate and globe valves may be used. Strength of valves should be consistent with other components in the system.

Conventional packing and lubricants for hydrocarbon gas service are recommended. Packing and lubricants should be free of copper or traces of copper.

For joining the valves to the system, alloy studs that meet ASTM A-193, Grades B6 and B7, with ASTM A-194, Class 2H heavy hex nuts have proven satisfactory in detonation tests.* They are recommended for medium-pressure service. Bolts and nuts that comply with ASTM A-307 are commonly used for low-pressure service.*

Gaskets made of red rubber or compressed asbestos can be used. Asbestos composition ring gaskets, 1/16-inch thick have performed well in medium-pressure detonation tests.

Use of expansion joints is not recommended. The necessity for their use should be avoided during layout and piping design of the system. Where the use of a slip-joint cannot be avoided, proper protection against freezing and corrosion should be provided. (Suitable designs are illustrated in the full committee report.)

Use of Pressure Boosters

Centrifugal, liquid-sealed compressors have been used successfully and extensively to boost the pressure in an acetylene system. Water is the common seal liquid. Whenever dry acetylene is required, another seal liquid which is compatible with the process can be substituted.

The booster system should be protected by adequate controls against the possibility of air entering the suction side, or of the discharge pressure exceeding 120 per cent of the normal value.

A pressure-actuated switch should be considered for the discharge line downstream of the flash arrester. It should be so adjusted that it stops all booster drives in the event of excessive loss in

---

*Copies of ASTM specifications are available from American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

line pressure such as might be caused by an open emergency vent, a blown rupture disc or a break in the transmission line.

Coolers and Separators

It is best to use a gas temperature not to exceed 120° F at the discharge of the booster system in order to minimize problems associated with excessive water condensation through the subsequent piping. Either fin-tube or shell-and-tube coolers are usually used for this service.

The centrifugal, liquid-seal compressor usually incorporates its own liquid separator. Line coolers, when necessary, should also incorporate a condensate trap or separator in order to remove excess condensate.

Liquid drained from separators carries with it dissolved and entrained acetylene. If the seal liquid is a once-through-flow, not being recirculated through a closed system, the economical and safe disposal is back through the generator wherever acetylene is produced from calcium carbide.

When gage glasses are necessary on separators, they should be designed for pressure service, guarded against mechanical failure and fitted with stainless steel ball checks top and bottom.

Protective Devices

Consideration should be given to installing packed flash arresters at the following locations:

Terminus of the acetylene manufacturing area, where the acetylene enters the transmission system.

Entrance of a gasholder floating on the line, or downstream of a gasholder operating with through-flow of gas.

Exit of a pressure booster.

Entrance of each consuming plant.

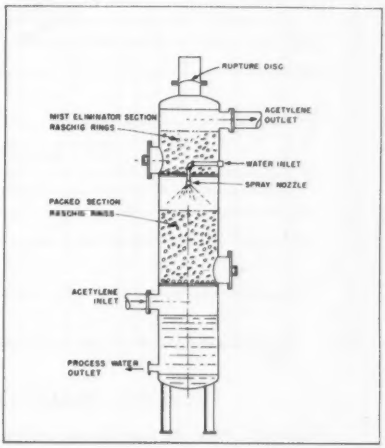
Function of the packed-tower flash arrester is to stop the propagation of deflagrations or detonations in transmission lines in either direction and to prevent the propagation of such explosions into plant equipment.

American operating experience indicates that liquid-wetted-packed towers are satisfactory for both low-pressure and medium-pressure service. When the installation of a liquid-wetted arrester is impractical, the dry type may be considered.

Sketch C is a recommended design for a packed flash arrester. Complete design details are given in the IAA committee report, and in the following reference: H. Schmidt and K. Haberl, "Safety Measures Against Acetylene Decomposition at Low Pressures," *Technische Überwachung, Zeitschrift des TUV*, Dec. 1955, pp. 425–429.

Need for Rupture Discs

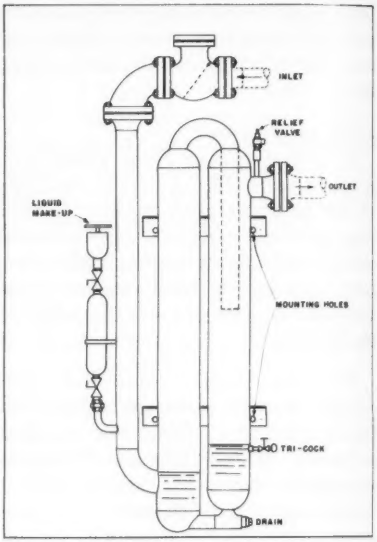
There is no known proof of the need for rupture discs at the packed-tower flash arrester. However, the practice is to install a rupture disc in the line



Sketch C. Typical packed tower flash arrester.

adjacent to the arrester vessel when the line is longer than the predetonation distance. The lower curve of Figure 1 attempts to show the least acetylene pressure at which a flame of the deflagration type can propagate throughout a long tube of any diameter. The upper curve shows pressures required for detonation. The IAA committee report contains a predetonation distance chart (Figure 2) showing the effect of acetylene pressure and pipe diameter on the distance a deflagration will travel before a detonation develops.

Note, though, that rupture discs should not be used in piping systems which have a hydraulic back-pressure valve such as that shown in Sketch D. Here, sudden venting would cause the loss of liquid in the hydraulic valve.



Sketch D. Hydraulic back-pressure valve.

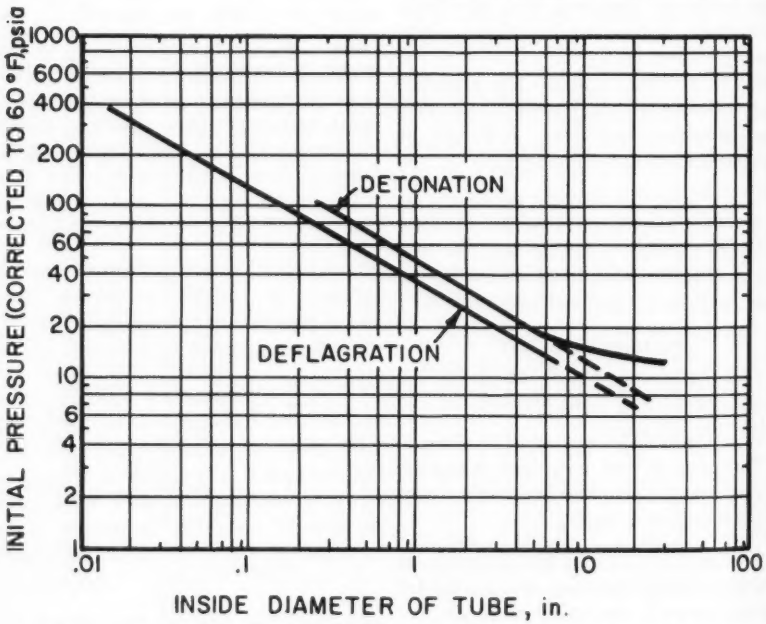


Figure 1. Pressure required for deflagration and detonation of acetylene in long tubes at room temperature with non-shock thermal ignition. Solid curves are based on experiment; broken-line extensions show predicted behavior at larger diameters with large-area ignition sources.

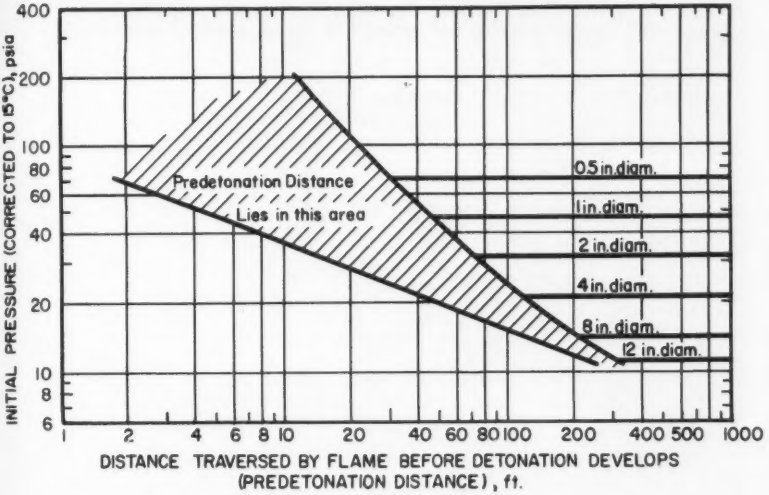


Figure 2. Predetonation distance chart for acetylene in tubes assuming non-shock thermal ignition near a closed end. The range shown for any pressure is valid only if the pressure is above the lower limit for detonation shown for various diameters at the right. The horizontal lines show the least pressures required for detonation in tubes of different diameter (taken from the upper curve of Figure 1).

The function of hydraulic back-pressure valves is to stop the propagation of deflagrations and detonations in the acetylene transmission line. Most designs are for medium pressure service since it is the most common.

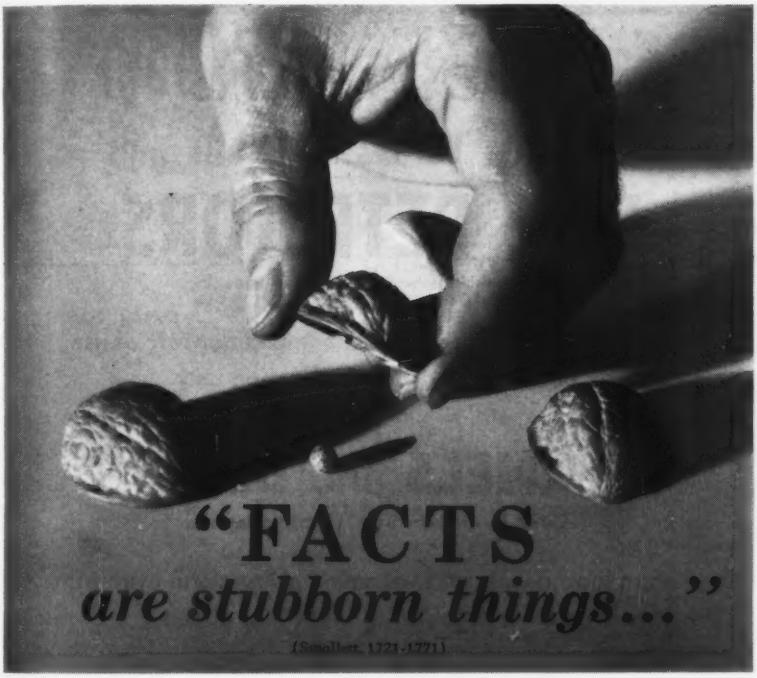
Complete design details of these valves are given in the full report. For design information on other parts of the system, and valuable background material, the full report should be consulted.

INDEX TO ADVERTISERS

January 1961

	Page
American District Telegraph Company (ADT)	A1
Ansul Chemical Company	A22
Armstrong Cork Company	A30, A31
Autocall Company	A27
"Automatic" Sprinkler Corporation of America	A32
Cardox, Division of Chemetron Corporation	*Inside Front Cover*
Celotex Corporation	A3
Central Station Electrical Protection Association	A12
Central Station Signals, Inc.	A20
Chicago Bridge & Iron Company	A7
Dusing & Hunt, Inc.	A18
Fire Alarm Thermostat Corporation	A2
Fyr-Fyter Company	A5
Gamewell Company	*Inside Back Cover*
Grinnell Company, Inc.	*Outside Back Cover*
Kelmore, Inc.	A29
Walter Kidde & Company, Inc.	A6, A19
Kinnear Manufacturing Company	A10
Kuhns Brothers Company	A9
M & H Valve and Fittings Company	A24
R. C. Mahon Company	A21
National Foam System, Inc.	A17
Notifier Corporation	A25
Pacific Mills Domestics (Industrials)	A15
Raisler Corporation, Raisler Sprinkler Division	A14
Reliable Automatic Sprinkler Company, Inc.	A11
Rockwood Sprinkler Company	A26
Shand and Jurs Company	A28
Star Sprinkler Corporation	A13
Tokheim Corporation, General Products Division	A23
Viking Corporation	A8
Vonnegut Hardware Company, Von Duprin Division	A16
William Wallace Company, Metalbestos Division	A4

Page
...A1
...A22
30, A31
...A27
...A32
ont Cover
...A3
...A12
...A20
...A7
...A18
...A2
...A5
ack Cover
ack Cover
...A29
A6, A19
...A10
...A9
...A24
...A21
...A17
...A25
...A15
...A14
...A11
...A26
...A28
...A13
...A23
...A8
...A16
...A4



Why play guessing games when it comes to plant security?

In safeguarding life, property and profits against fire, burglary and other hazards, ADT automatic protection services have *proved* their effectiveness and dependability.

Here's the evidence in a nutshell:

It's a fact — during the past ten years, ADT waterflow alarm service provided subscribers with an immunity against fire loss that averaged 99.98 per cent of protected values.

It's a fact — throughout the same period, subscribers to ADT burglar alarm service enjoyed an immunity against burglary loss that averaged 99.99 per cent.

Dependability like this warrants serious consideration. Other facts about plant protection are contained in an illustrated booklet that's available (Canada and U. S. only) by writing to us. Better still, call the ADT security specialist listed in your telephone directory.

AMERICAN DISTRICT TELEGRAPH COMPANY
Executive Office: 155 Sixth Avenue, New York 13, N. Y.
A NATIONWIDE ORGANIZATION

ADT

HEADQUARTERS

for

FIRE DETECTORS

Listed by Underwriters' Laboratories, Inc.

All temperature ratings in either combination rate of rise and fixed point or fixed point operation only.

PANELS and **BELLS**

Listed by Underwriters' Laboratories, Inc.

Return loop panels that will sound a fire alarm even with a break, or other trouble, on the wiring circuit.

COMPLETE LINE OF FIRE DETECTION EQUIPMENT FOR INSTALLATION IN

- SCHOOLS
- NURSING HOMES
- STORES
- RESIDENCES

Consult us for prices and information

FIRE ALARM THERMOSTAT CORP.

55 WEST 23rd STREET — NEW YORK 10, N. Y.

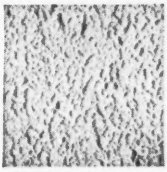
INCOMBUSTIBLE CEILINGS
—*and they're ALL* by "CELOTEX"

Here are some examples of "Ceilings by Celotex" that meet building code requirements for incombustibility.

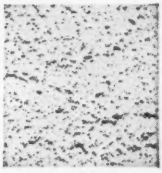
ALL ARE U. L. LISTED

FISSURED MINERAL FIBER TILE

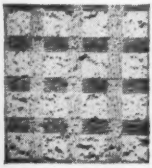
STRIATONE*



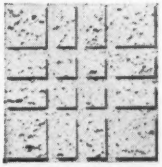
TEXTURE-TONE*



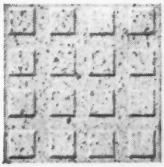
CELOTONE®



"DESIGN" CELOTONE® Plaid



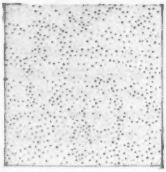
"DESIGN" CELOTONE® Monarch



"DESIGN" CELOTONE® Empress

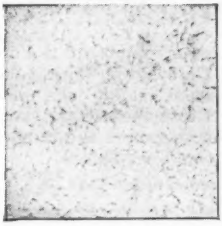
"DESIGN" CELOTONE® Modulo

PERFORATED MINERAL FIBER TILE



SERENE
Also available in Random Perforated Patterns and Standard Perforated Pattern.

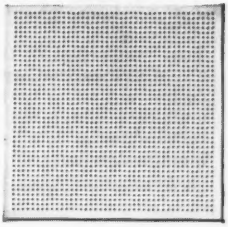
GLASS FIBER PANELS



SUPRACOUSTIC®

*TRADE MARK

GYPSUM BOARD ASSEMBLY



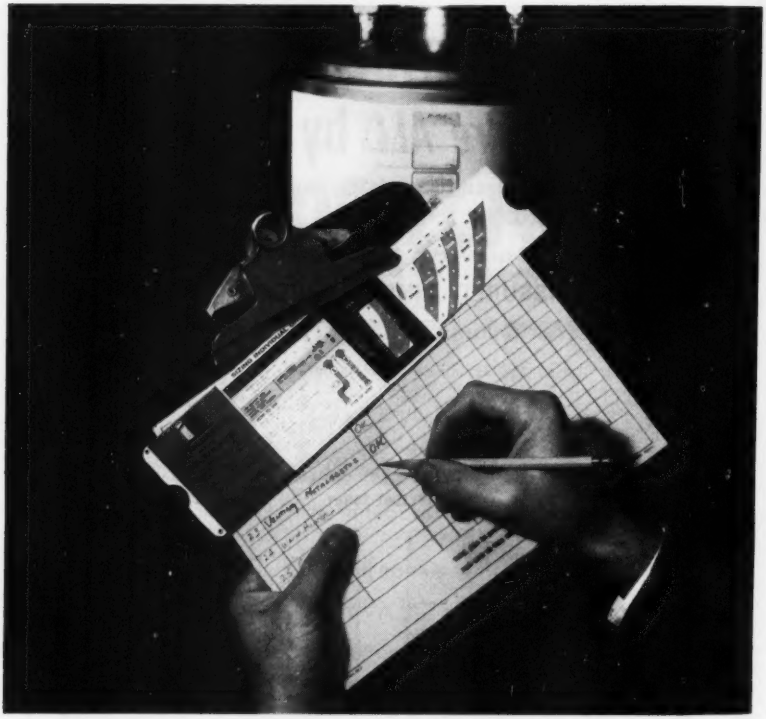
CAVITY TILE†

†U. S. PAT. NO. 2,838,806

If it's "by CELOTEX" you get QUALITY . . . *plus!*

Acousti-CELOTEX
REGISTERED U.S. PAT. OFF.
SOUND CONDITIONING PRODUCTS

Products to Meet Every Building Code • THE CELOTEX CORPORATION • 120 S. LA SALLE ST., CHICAGO 3, ILL.
In Canada: Dominion Sound Equipments, Limited, Montreal, Quebec



You can tell a Metalbestos Man

by the Safety Check he uses

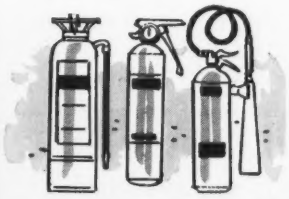
That "slide rule" on the installer's clipboard is a brand new service tool—the **Metalbestos Gas Vent Calculator.** With it the Metalbestos man can figure vent sizing for all types of heating jobs, quickly and accurately... and double-check the results to make certain his installations meet code requirements. It's based on the same established formula behind the Metalbestos Safety System Gas Vent Tables.

See your local Metalbestos representative or write Dept. I-1

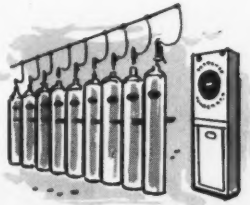
AVAILABLE ONLY FROM METALBESTOS • Gas Vent Calculator • Reader's Digest Reprints • Color Slide Film "Heat in Harness" • Venting Schools • Vent Installation Handbook • Gas Vent Service Bulletins • Safety System Seals • Sales & Technical Literature • Ad & Article Reprints • Direct Mail Materials.

METALBESTOS DIVISION
WILLIAM WALLACE COMPANY
BELMONT, CALIFORNIA

MANUFACTURING PLANTS IN BELMONT, CALIFORNIA • LOGAN, OHIO



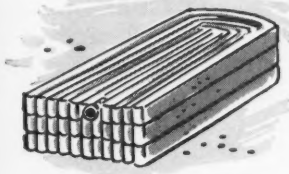
Fyr-Fyter, Pyrene-C-O-Two Buffalo fire extinguishers



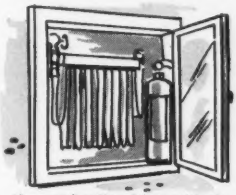
C-O-Two carbon dioxide, dry chemical, foam systems

Globe sprinkler systems

Fyr-Fyter fire alarm systems



Municipal, industrial fire hose



Hose and extinguisher cabinets

Wooster brass fire equipment

Fire department supplies

complete fire protection from Fyr-Fyter

Complete fire protection requires many different kinds of equipment. Fyr-Fyter can supply all the dependable, high-quality products and services you'll need!

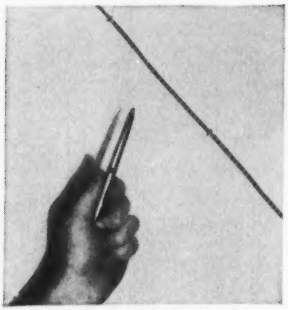
You also surely need the deep knowledge and experience acquired by Fyr-Fyter representatives in industrial, commercial, institutional, municipal and household fields. These men are uniquely qualified to survey, analyze and recommend the proper equipment to guard every fire risk.

To contact the representative nearest you, look in the yellow pages under "Fire Protection Equipment" or write to: The Fyr-Fyter Company, 221 Crane Street, Dayton 1, Ohio.

Fyr-Fyter

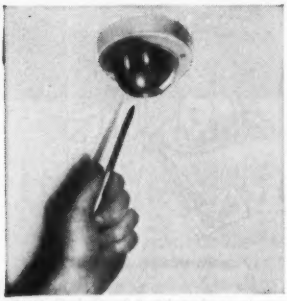
Representatives and Distributors in all principal cities.

FOR LOW-COST, DEPENDABLE FIRE DETECTION-ALARM!



Kidde Atmo fire detector tubing.

KIDDE ATMO: Ideal for schools, hospitals, plants, public buildings, Kidde Atmo Fire Detecting and Alarm Systems use highly sensitive rate-of-temperature-rise detection tubing. Easy to install, simple to maintain, Atmo systems give fast warning in first stages of fire.



Kidde Fyrindex detection elements.

KIDDE FYRINDEX: Now — dependable fire detection at the lowest possible cost. Kidde Fyrindex features fast-acting, self-resetting detectors, comes in either rate-of-rise, fixed temperature or combination models.

Both Kidde systems are U.L. and F.M. approved; sound alarms locally, at central station, or at municipal fire headquarters; feature one to one hundred zone control and annunciator panels.

For complete information about Kidde fire detection, write today.

Kidde

Kidde Ultrasonic & Detection Alarms Division
Walter Kidde & Company, Inc.
151 Brighton Road, Clifton, New Jersey

Maximum Security

This 250,000-gallon Horton Waterspheroid is on 24-hour fire watch at Automatic Electric Company's multi-million dollar plant near Chicago — ready to supply water *instantly* to 14,500 sprinkler heads. Then, too, it stores water for the general daily needs of the huge facility.

Waterspheroids — available in standard capacities ranging from 250,000 to 500,000 gallons — combine dependable service and modern design with the *plus* advantage of skyline advertising. Horton Waterspheres provide the same benefits in the 25,000 to 250,000-gallon capacity range. Write today for the brochure *The Watersphere and Waterspheroid.*

CHICAGO BRIDGE & IRON COMPANY

CBI

332 SOUTH MICHIGAN AVENUE
CHICAGO 4, ILLINOIS

OFFICES AND SUBSIDIARIES IN PRINCIPAL CITIES THROUGHOUT THE WORLD

Good fire protection is a worthwhile investment at any price. However, it is only good business to get the best equipment at the most realistic cost. This is where Viking can be of great service to you.

VIKING

OFFERS THE BEST IN FIRE PROTECTION

from the ground up

For plant, office or warehouse; an automatic sprinkler system to meet every requirement — Wet, Dry-Pipe, Deluge or Pre-action. Engineered, manufactured and installed by fire protection experts. Pays for itself in reduced insurance costs.

the Viking corporation

HASTINGS, MICHIGAN

NOW... Kuhns ductile iron fittings

For Sprinkler Systems

Kuhns ductile iron pipe fittings—the newest development in piping—provide an extra margin of operating safety for sprinklers, high pressure lines and other vital piping systems. High structural strength and resistance to thermal shock help these fittings prevent leakage caused by vibration, temperature changes or misalignment.

"K" Pipe Lock Couplings

Listed for 800 psi by Underwriters' Laboratories, Inc., these couplings have a safety factor of five times the UL listing for 2½" through 6" and four times UL listing for 8". Sizes: 2½" through 8". Look for the "800 D" on each.

"K" Flanges and Flanged Fittings

Pressure rating, 500 psi by Underwriters' Laboratories, Inc. for elbows, base elbows, 45° elbows, side outlet elbows, tees, side outlet tees, and reducers in straight and reducing sizes. Flat faced flanges standard. Extra heavy flange dimensions and raised faces available. Look for the "DI 500" on each.

Complete range of sizes through 12".

"K" Screwed Fittings *

Pressure ratings listed by Underwriters' Laboratories, Inc.

STEAM AND OIL AT 550°F

¼" to 3".....300 lbs.

LIQUID AND GAS AT 150°F

¼" to 1".....2000 lbs.

1¼" to 2".....1500 lbs.

2½" to 3".....1000 lbs.

**Ductile iron fittings are available in any size in Kuhns complete cast iron line, ¼" through 12".*

Note: These fittings are excellent for liquefied petroleum gas systems. Look for the "DI 300" on each.

Send for our catalog or contact your wholesaler.

THE KUHNS BROTHERS CO.

1800 McCALL STREET, DAYTON, OHIO

EXCLUSIVE

Kinnear

"AKBAR"

Rolling

STEEL

Fire

SHUTTERS and

Doors

Labeled by Underwriters' Laboratories, Inc.

Automatic Closure In Case of FIRE!

*"Akbar Fire Doors" for openings up to 120 sq. ft., but not exceeding 12′ in width or height, bear the label of the Underwriters' Laboratories, Inc. For larger openings, doors not exceeding 24′ in either width or height will be provided with an Underwriters' Laboratories certificate of inspection indicating that the door's construction conforms to specifications of Underwriters' Laboratories, Inc.

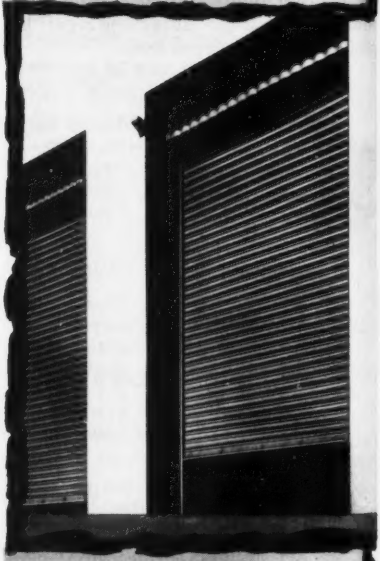
The KINNEAR Manufacturing Co.

FACTORIES:
2250-70 Fields Ave., Columbus 16, Ohio
1742 Yosemite Ave., San Francisco 24, Calif.

KINNEAR ROLLING DOORS
Saving Ways in Doorways

Offices and Agents in All Principal Cities

3-HOUR Class A Label
of the Underwriters' Laboratories, Inc. is carried on AKBAR Doors for ALL Installations* in
interior
Fire Walls, Corridor and Room Partitions and Vertical Shaft Openings



1½-HOUR Class D Label
of the Underwriters' Laboratories, Inc. is carried on AKBAR Doors for ALL Installations* in
exterior
Wall Openings

"Worthy of Your Confidence!"

Reliable Automatic Sprinkler Devices have been protecting life and property for more than 35 years. The practical design and rugged construction are universally approved and accepted by all Fire Insurance and Governmental Authorities. Reliable Automatic Sprinklers effect maximum reductions in fire insurance premiums.

Reliable's complete line provides a wide selection of Sprinkler Devices to meet any condition, including: Automatic and Open Sprinklers, Alarm Valves, Dry Pipe Valves, Accelerators, Electric Alarm Switches, Water Motors, and all Sprinkler System Accessories.

Experienced Reliable Licensees are located throughout the United States, Canada, and foreign countries. They are expertly qualified to design and install a Reliable Sprinkler System for your specific needs.

THE RELIABLE AUTOMATIC SPRINKLER CO. INC.
Manufactured and Distributed by
525 NORTH MACQUESTEN PARKWAY, MOUNT VERNON, N. Y.

Nation Wide
Central Station Protection Services

Sprinkler Valve Alarm — Complete Sprinkler Supervisory — Manual Fire Alarm — Automatic Fire Alarm — Temperature Alarm — Oil Burner Supervision — Burglar Alarm — Hold-Up Alarm — Vault & Safe Protection

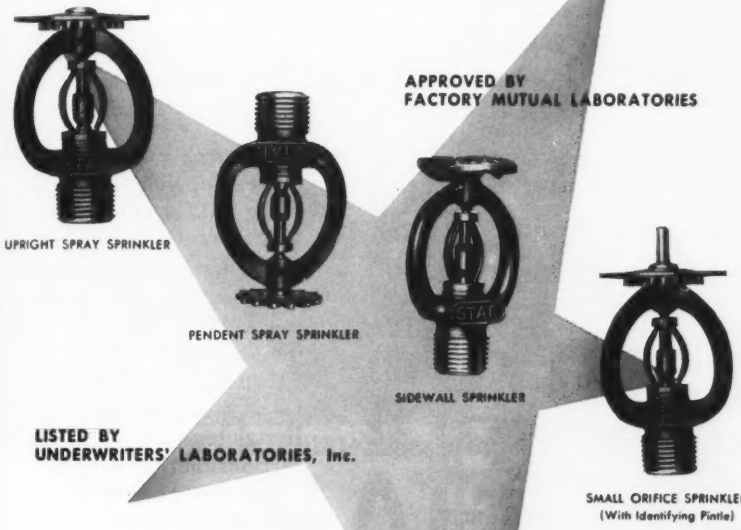
Available from these members of

Central Station Electrical Protection Association

ALBANY, NEW YORK	**ALBANY PROTECTIVE SERVICE** 99 Jay Street
BOSTON, MASS.	**CALL'S CENTRAL STATION ALARMS** 69 Washington Avenue, Chelsea
CHICAGO, ILLINOIS	**CENTRAL WATCH SERVICE** 214 West Ohio Street
CLEVELAND, OHIO	**MORSE SIGNAL DEVICES** 6707 Carnegie Avenue
DALLAS, TEXAS	**SMITH DETECTIVE AGENCY & NIGHTWATCH SERVICE, INC.** 610 N. Akard Street
DAYTON, OHIO	**DAYTON ELECTRONICS ALARM & SIGNAL CO.** 301 West Monument Avenue
DENVER, COLORADO	**DENVER BURGLAR ALARM COMPANY, INC.** 422-21st Street
DETROIT, MICHIGAN	**MICHIGAN STILL ALARM CO.** 10410 W. Chicago Blvd.
HONOLULU, HAWAII	**CENTRAL ALARM COMPANY, LTD.** 1755 Kapiolani Boulevard
HOUSTON, TEXAS	**McCANE-SONDOCK ALARM SYSTEMS** 1612 Austin Street
LOS ANGELES, CALIF.	**MORSE SIGNAL DEVICES OF CALIFORNIA** 211 So. LaBrea Avenue
MANCHESTER, N. H.	**GRANITE STATE ALARM INC.** 839 Elm Street
MILWAUKEE, WIS.	**MERCHANTS POLICE SIGNAL & ALARM CO.** 429 W. Michigan Street
MINNEAPOLIS, MINN.	**AUTOMATIC ALARM CORP.** 2404 Lyndale Avenue, South
NEWARK, NEW JERSEY	**NEWARK DISTRICT TELEGRAPH CO.** 372 Plane Street
NEW YORK, NEW YORK	**CENTRAL STATION SIGNALS, INC.** 53 West 23rd Street
PEORIA, ILLINOIS	**PROTECTION ALARMS, INCORPORATED** 725 West Main Street
PHILADELPHIA, PENNA.	**OWL PROTECTIVE CO., INC.** 120 No. Camac Street
PHILADELPHIA, PENNA.	**ROBINSON ELECTRONIC SUPERVISORY CO.** 15th and Chestnut Streets
PHOENIX, ARIZONA	**CENTRAL ALARM** 916 West Adams Street
ST. LOUIS, MISSOURI	**POTTER ELECTRIC SIGNAL & MFG. CO., INC.** 1211 Pine Street
SAN FRANCISCO, CALIF.	**PACIFIC FIRE EXTINGUISHER CO.** **AMERICAN BURGLAR ALARM DIVISION** 165 Jessie Street
WASHINGTON, D. C.	**FEDERAL ENGINEERING CO., INC.** 1004 Sixth Street, N.W.

STARGARD

GIVES YOU MORE — FOUR WAYS



1 **SUPERIOR PROTECTION** . . . due to more efficient water distribution. Proven by tests under actual fire conditions for all classes of hazards.

2 **MORE EFFECTIVE USE OF LESS WATER** . . . because wider distribution and break-up of the water discharged provides greater cooling and extinguishment.

3 **CEILING PROTECTION BY COOLING — NOT WETTING** . . . All the water goes onto the fire. The break-up of water results in complete cooling and control of flammable vapors.

4 **MORE FIRE CONTROL WITH FEWER SPRINKLERS** . . . because ceiling temperatures are kept lower, fewer sprinklers open. Immediate water saturation of the fire area prevents the spread of fire. Hot gases become impotent in the cooled atmosphere.

STAR SPRINKLER CORPORATION

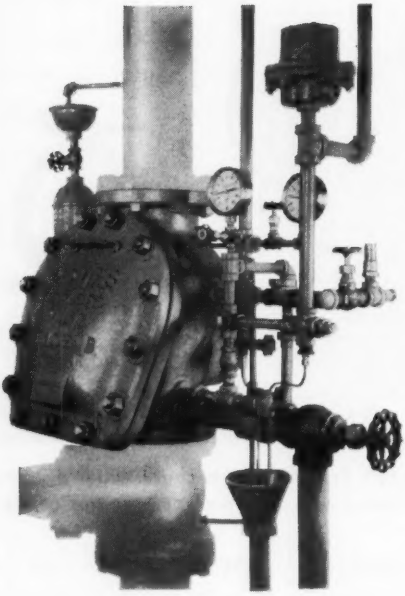
Westmoreland & Collins Sts., Phila. 34, Pa.

Licensees in principal cities of the United States and Canada

NEW IMPROVED

GRIMES **MODEL B**

DRY PIPE VALVE



Another new GRIMES device which has been designed for functional efficiency and simplicity in maintenance. The full size cover plate makes the entire interior of the valve accessible. Cleaning and re-setting takes but a few minutes. If maintenance is your responsibility specify "Grimes". For more information write Raisler today.

GRIMES DEVICES ARE APPROVED BY ALL INSURANCE INTERESTS

RAISLER

SPRINKLER DIVISION

RAISLER CORPORATION, 750 Third Ave., New York 17, N.Y.

Licensees in all principal cities in the United States and Canada

DON'T GET BURNED! GET SAFETY CLOTHING MADE OF

SAFETEX®

FIRE RETARDED FABRIC!

Fight fire with a **real** fire-fighter—Safetex! It provides maximum clothing-safety protection and cotton comfort against fire and burns... protects workers and plant reputation! Numerous launderings do not affect the superior flame resistance of Safetex... nor do dry-cleanings. There is no afterglow. Next time you order safety clothing made with fabrics requiring a flame retardent finish, specify Safetex to your garment supplier... or call Wamsutta/Pacific Industrial Fabrics Division for full information!

When it comes to safety.. Think of Safetex

WAMSUTTA/PACIFIC
INDUSTRIAL FABRICS, 1430 BROADWAY, NEW YORK 18, N. Y.

Show this dramatic safety film . . . free

● Use this forceful public service film as the highlight of your program on safety and safety training. In no sense a product story, "Safe Exit" is a thought-provoking contribution towards arresting our record of more than 30 lives a day due to fire and panic.

Schedule "Safe Exit" for your club, class or meeting now. 10 minutes . . . 16 mm . . . black and white . . . sound . . . no charge . . . postage paid both ways.

FREE

VONNEGUT HARDWARE CO., VON DUPRIN DIV.
408 West Maryland
Indianapolis 25, Indiana Date.....

Yes, we wish to show the 16 mm, sound, B& W movie, "SAFE EXIT."

Date desired..... or.....

Type of audience.....

We understand film is rent-free, postage paid. We agree to return film the day following our showing.

Organization.....

Authorized by.....

Address.....

City..... Zone..... State.....

Von Duprin PANIC DEVICES ASSURE SAFE EXIT ®

one-man foam station

provides "first-aid" foam protection till your heavy equipment arrives

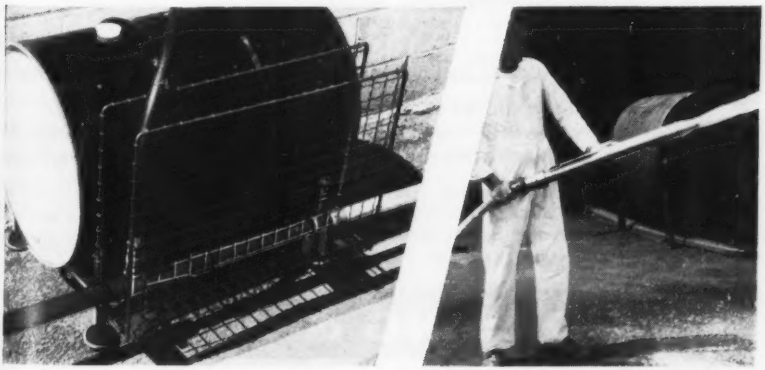
Does your plant rely on mobile equipment . . . foam trucks or cumbersome chemical foam equipment . . . to fight fire in hazardous locations such as pump house and manifold pit areas, truck and tank carloading racks, marine docks?

If so, you'll want to know about the National Aer-O-Foam Station. This new, compact, economical unit can be installed permanently near each hazard, ready to produce foam instantly and control the fire until the big equipment arrives.

Operated by only one man, the Aer-O-Foam Station delivers up to 600 gpm of tough foam for as long as 30 minutes. Ask for full details from your nearest National Foam office or distributor.

National Foam System, Inc.

West Chester, Pa.



With hose stripped out and pick up tube inserted in 55 gallon drum, water valve is opened. Foam in seconds!

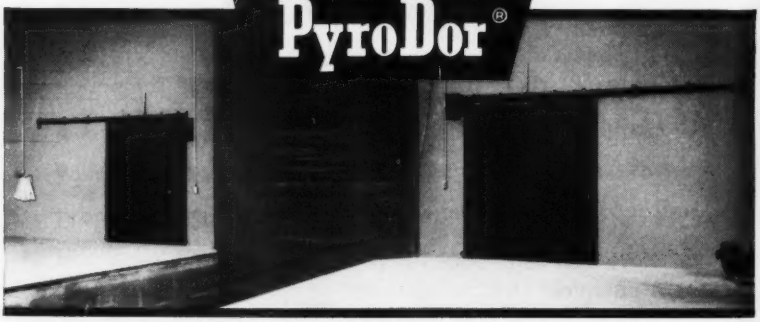
Architects and Engineers specified **MAXIMUM**

PROTECTION and UTILITY

FOR THE NEW BUFFALO DUNLOP TIRE WAREHOUSE

with the NEW D-H SLIDING PyroDor®

Underwriters' Labeled



MODERN FLUSH FIRE DOOR DESIGN
COMPLEMENTS STREAMLINE BUILDING

The *ultimate* in safety and protection against fire was the prime factor in the selection of Dusing and Hunt Sliding *PyroDors* . . . for all door openings in fire walls. Here are a few of the many *plus* values whenever D & H Sliding Fire Doors are specified:

LIFETIME GUARANTEE against warping, twisting or shrinking of the PyroDor or deterioration of the mineral core caused by rotting or other natural causes.

RUST-RESISTING Heavy gauge steel bonded to core provides "surface-plate" flatness. Armored edges surround entire door.

MODERN HARDWARE Easy operating for large size doors. Fully concealed door hangers and guide rollers protected from damage, dust or dirt.

PYROMATIC AUTOMATIC DOOR CLOSER Only Underwriters' Labeled automatic closing device in sliding fire doors. Permits manual operation at all times . . . yet, fully automatic at controlled speed in the event of a fire.

NEW 8-page Catalog gives complete details, specifications and UL Rating Chart for Class A, B, or C Labels. Write for your copy now. *Consult the Yellow Pages or Sweet's Architectural File for your nearest D & H Distributor.*

D-H AND **DUSING & HUNT, Inc.**

67 LAKE ST., N. LE ROY, N. Y.

Killing blow! It takes only minutes for fire to burn your business to a crisp. Guard against the danger of a crippling flammable-liquid fire (as in the spray booth above) with a *fully automatic* Kidde carbon dioxide extinguishing system. Approved by U.L. and F.M., Kidde systems smother flammable-liquid and electrical fires in seconds, leave no mess, turn off power and sound alarms . . . get you back in production fast. Kidde's 35 years of experience can help you protect any hazard. Write Kidde today and find out how.

Industrial and Marine Division

Walter Kidde & Company, Inc.
151 Main St., Belleville 9, N. J.
Walter Kidde & Company of Canada Ltd.
Montreal—Toronto—Vancouver

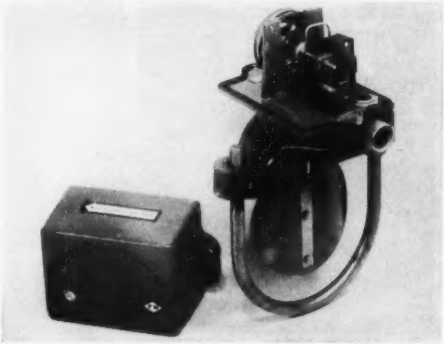
Kidde (K Kidde)

The words 'Kidde', 'Lux', 'Lux-O-Matic', 'Fyre-Freez' and the Kidde seal are trademarks of Walter Kidde & Company, Inc.

CENTRAL STATION SIGNALS, INC.

Manufacturers of all kinds of approved devices used in Central Station Systems or Class 'A' or Class 'B' Proprietary Fire Alarm Systems, either automatic or manual.

53 WEST 23rd STREET . . . . . NEW YORK 10, N. Y.



5-inch size shown above. To install simply drill 2-inch hole in pipe.

Model PRS-1

Sprinkler Waterflow Alarm

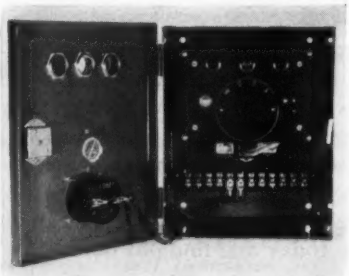
This device is approved by Factory Mutual Laboratories and Underwriters' Laboratories, Inc.

- This device is also made as Model PRT-1, a coded waterflow transmitter.

- Also made in explosion proof models.
- Made in all sizes from 2½" to 8".
- Has instantly recycling pneumatic retarding device, preventing false alarms.
- Has enclosed electrical contacts for any voltage not exceeding 15 amp. 125 volts, A.C. and ½ amp. 125 volts, D.C. Operates on all water pressures or surges.

Proprietary & Remote Panels For Fire Headquarters

This Fire Headquarters Unit is designed to be used primarily for the receipt of signals at a remote station when actuated by a local alarm unit in the protected premises. It is electrically supervised and will give a trouble signal in case of open and ground and will also receive an alarm under these conditions. This panel is made for 12 or 24 volt D.C. operation.



Local Non-Coded Fire Headquarters Unit

AUTOMATIC

ROLLING-STEEL FIRE DOORS

PREFERRED FOR USABILITY . . . SPECIFIED FOR PROTECTION

ABOVE: A Mahon Rolling Steel Fire Door Serves a dual purpose—an internal dividing wall and an automatic fire barrier. BELOW: Window shutters too, are Mahon—supplied in sizes to your need for full fire protection.

Automatic Fire Doors and Shutters from Mahon have been carefully engineered to offer you many advantages of safety and function. They are operated manually or mechanically in everyday use—automatically closing if fire breaks out. This quick action cuts off drafts, confines the blaze and reduces losses. No other type of fire door provides all of these important features: Underwriters' Label; vertical roll-up action, minimum space demands; all-metal construction; Bonderite-protected plus rust-inhibiting synthetic baked enamel; and quality built for long life. You will find a Mahon Automatic Fire Door or Shutter to suit your use . . . your property . . . your protection.

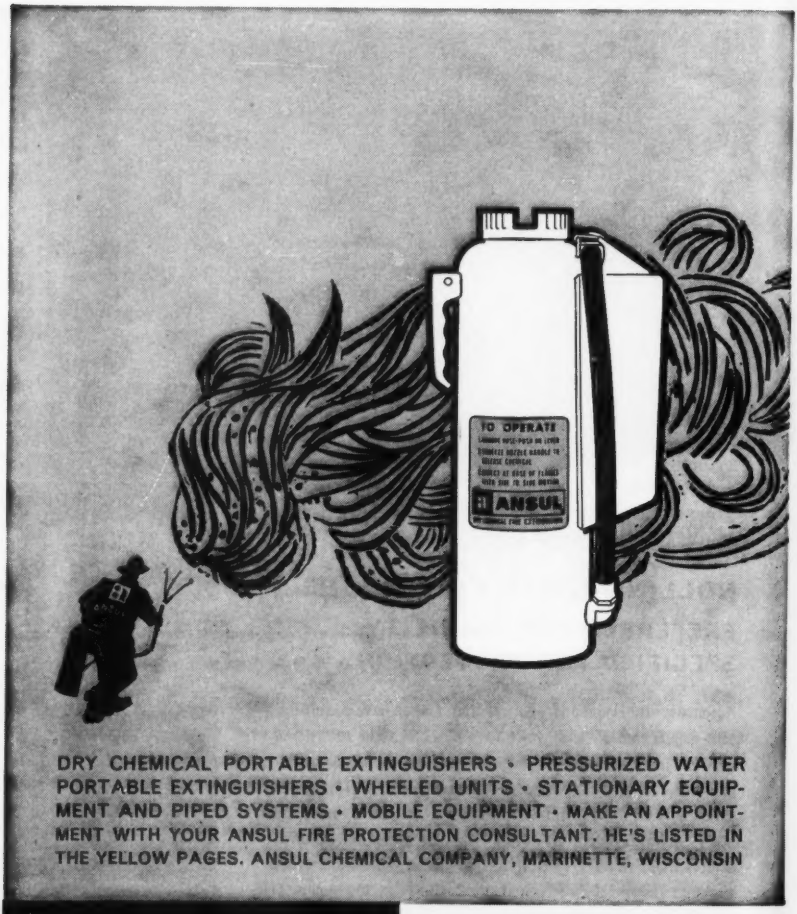
SEND FOR DESCRIPTIVE CATALOG G-60 OR SEE SWEET'S FILES

THE R.C. MAHON COMPANY
Detroit 34, Michigan

MANUFACTURING PLANTS—Detroit, Mich. and Los Angeles, Calif. BRANCH OFFICES in New York, Chicago, Los Angeles and San Francisco. SALES REPRESENTATIVES in all other principal cities.

M A H O N

OTHER MAHON BUILDING PRODUCTS INCLUDE UNDERWRITERS' RATED METALCLAD FIRE DOORS



DRY CHEMICAL PORTABLE EXTINGUISHERS • PRESSURIZED WATER PORTABLE EXTINGUISHERS • WHEELED UNITS • STATIONARY EQUIPMENT AND PIPED SYSTEMS • MOBILE EQUIPMENT • MAKE AN APPOINTMENT WITH YOUR ANSUL FIRE PROTECTION CONSULTANT. HE'S LISTED IN THE YELLOW PAGES. ANSUL CHEMICAL COMPANY, MARINETTE, WISCONSIN

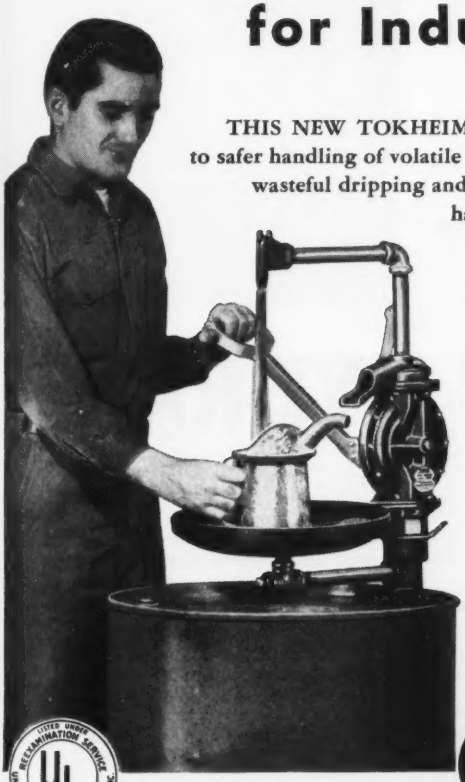
new products, new ideas for better fire protection

ANSUL

FIRE FIGHTING EQUIPMENT
REFRIGERATION PRODUCTS
INDUSTRIAL CHEMICALS

SAFER

liquid handling for Industry



THIS NEW TOKHEIM HAND PUMP contributes to safer handling of volatile liquids wherever used. Stops wasteful dripping and slippery floors. Reduces fire hazard and accidents common to other methods of liquid transfer. Approved for handling petroleum liquids —ideal for many others. Available in 22 different models for 'most any use— from pipe lines to drums, or underground tanks, with hose or spout outlets. Order from your dealer, your oil company, or your Tokheim representative.

Write factory for literature.

LISTED UNDER RE-EXAMINATION SERVICE UNDERWRITERS' LABORATORIES, INC. UL

QUALITY TOKHEIM HIGH VACUUM HAND PUMPS

General Products Division

TOKHEIM CORPORATION

DESIGNERS AND BUILDERS OF SUPERIOR EQUIPMENT SINCE 1901

1686 WABASH AVENUE FORT WAYNE, INDIANA

Subsidiaries: Tokheim International, A. G., Lucerne, Switzerland; GenPro Inc., Shelbyville, Indiana; Tokheim of Canada, Ltd., Toronto, Ontario

Champion
Fire Fighters

COMPRESSION TYPE FIRE **HYDRANT**

MH

Above all else, M & H Fire Hydrants are reliable and dependable fire fighting equipment. They deliver when the need arises, if there is water in the mains. Their high flow efficiency is due to an unobstructed, large waterway which has the same diameter its entire length.

Dry top, dry barrel when not in use, eliminates danger of damage by freezing. Operating parts are bronze or bronze bushed. Easy to lubricate.

Manufactured according to A. W. W. A. standard specifications or Underwriters and Factory Mutuals approved; in conventional model, traffic model or flush-type model; sizes 4¼, 4½, 5¼ and 6¼. For complete information, address

M&H VALVE
AND FITTINGS COMPANY
ANNISTON, ALABAMA

SUBSIDIARY OF W WALWORTH

from

NOTIFIER...

a complete line of

Console and cabinet equipment

Manual and Automatic Thermostats

DETECTION and NOTIFICATION devices

CONTROL equipment

ALARM devices

including Notifier's new

N-CO-BELL®

in all standard voltages, created with imagination, not imitation

N-CO-BELL's controlled stroke provides superior gong vibration producing a distinctive and arresting sound. Low amperage drain allows more bells per circuit.

and now, another first from Notifier!

NEW PLUG-IN UNITS (with 5 year Guarantee)

Eliminate tampering by untrained personnel with NOTIFIER'S *plug-in units*—the first in the field.

Remember—NOTIFIER has the most complete line of fire detection and notification devices, control equipment and alarm devices. They can develop a system for you regardless of the size or location of your operation.

NOTIFIER CORPORATION also manufactures

- Control Panels (498 Models)
- Proprietary Systems
- Auxiliary Control Relay Equipment
- Tripping Devices
- Annunciators
- Special Power Supplies
- Gate Valve Switches
- Post Indicator Valve Switches
- Pressure Switches
- Local Water Flow Alarm
- Signaling Units
- Thermostats
- Security Patrol Stations
- Manual Break Stations
- Coding Devices
- Bells (1,664 Models)
- Single Stroke Bells
- Polarized Bells
- Trickle Chargers

Attention qualified people: NOTIFIER CORPORATION is a fast growing concern. There's a bright future for you in selling, installing and servicing NOTIFIER systems. NOTIFIER also needs qualified engineers to work with architects and specifying engineers. If you're interested and feel you can qualify, write to

Refer to our catalogs

34A NO in Sweets' Architectural File

and

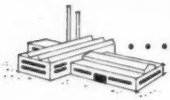
C6 NOT in Sweets' Plant Engineering File

NOTIFIER CORPORATION

3700 North 56th St. Lincoln, Nebraska

NOTIFIER FIRE ALARM

ROCKWOOD SPRINKLERS



. . . protect lives and property

. . . cut insurance cost

. . . pay for themselves

Fire in any building you manage — commercial, industrial or institutional — may result in losses which cannot be replaced.

You can avoid these losses — and make additional savings — by installing Rockwood Sprinklers.

Over 18 million Rockwood Water-FOG Sprinkler Heads have been installed for the protection of thousands of buildings, hundreds of thousands of lives and millions of dollars worth of property. Their proved efficiency is recognized by fire insurance companies, which grant substantial reductions in premium rates on all properties equipped with them. Another money-saving advantage is the elimination, in many communities, of fire doors, fire walls and other additions required in new construction, particularly in public buildings.

Rockwood can engineer a complete fire protection system to meet your particular needs and to handle any special fire hazards. The savings it brings you will be as continuous and sure as its protection. Out of premium reductions alone, your entire installation may pay for itself. And your working capital can be protected by deferred payments. Tested and listed by Underwriters' Laboratories, Inc. For further facts, write to Rockwood Sprinkler Company, 3007 Harlow St., Worcester 5, Massachusetts.

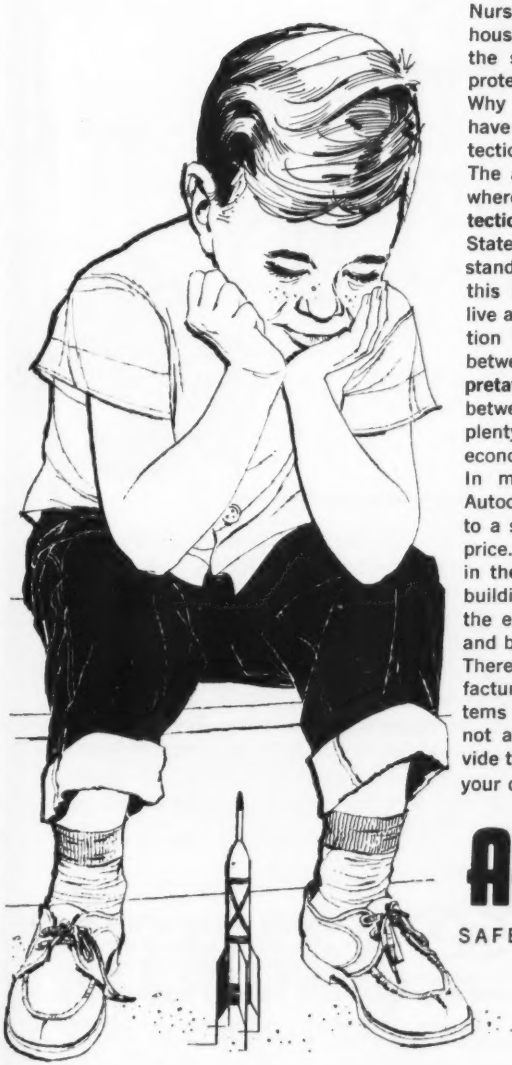
ROCKWOOD SPRINKLER COMPANY

A Division of The Gamewell Company • A Subsidiary of E. W. Bliss Company

Engineers Water . . . to Cut Fire Losses

Branch Offices in all principal cities

one of 62 million reasons why we won't join in the rat race!



Thousands of American schools have sub-standard fire protection. Nursing homes and hospitals that house the aged, the infirm and the sick are often more poorly protected.

Why don't these, of **all** places, have the finest automatic fire protection money can buy?

The answer, of course, is somewhere **someone compromised protection for price!**

State fire codes set minimum standards . . . but you who hate this compromise . . . you who live and eat and sleep fire protection know there is a wide gap between the **intent** and the **interpretation** of the law . . . that between these poles there is plenty of room for misguided economy.

In making fire alarm systems, Autocall will continue to build up to a standard and not down to a price. In short we refuse to join in the competitive "rat race" by building inadequate equipment at the expense of snuffed out lives and burned out jobs.

There are other reputable manufacturers of fire protection systems who feel as we do. You are not alone in your efforts to provide the best in fire protection for your community.

Autocall®

SAFEGUARDS MILLIONS

THE AUTOCALL COMPANY

SHELBY 2, OHIO

SALES OFFICES IN PRINCIPAL CITIES

SHAND AND JURS NEW DEVELOPMENT FOR INDUSTRY

B
A
C
S&J
Tank pressure holds valve "A" closed. Releasing pressure in line "B" by any means opens valve instantly – venting through port "C" to atmosphere or to discharge system.
Announcing the new self-energized, fail-safe
DEPRESSURING SAFETY VALVE

Now . . . a depressuring valve with simplified positive action, long needed to protect pressure type storage and process vessels from failure due to exposure fire! S&J Model 4280 Depressuring Valve is designed to minimize the problem of exposure fire by affording venting as outlined in API RP-520. This valve is energized by pressure in the protected vessel, and opening will always occur if pressure above the disc is relieved by any means. It may easily be instrumented for remote opening and closing. For service in corrosive environments, this S&J product may be specified in carbon or alloy steels. S&J research and development have paid off again—with safety dividends for you! Get the facts from your nearest S&J office, or write for detailed information.

SHAND AND JURS

A SUBSIDIARY OF GENERAL PRECISION

SHAND AND JURS CO.
2600 EIGHTH STREET
BERKELEY, CALIFORNIA

New York	Tulsa	Los Angeles	Houston	Chicago	Cleveland
285 Madison Ave.	Thompson Bldg.	6399 Wilshire Blvd.	M & M Bldg.	10409 S. Western Ave.	Terminal Tower

REPRESENTATIVES: Seattle • Denver • Pittsburgh • Montreal • Toronto • Vancouver • Calgary
Mexico City • Caracas • Rio de Janeiro • England • and other countries

AN ACCIDENT.....

This particular one occurred in the University of Iowa Chemistry Building on 5/4/59. The "kitchen type" refrigerator shown had been filled with chemicals and stored solutions. Only the shell remained after the explosion and resultant fire.

A number of these accidents occur yearly in laboratories and industrial plants all over America because a kitchen type refrigerator is used where an Explosion Proof refrigerator should be mandatory.

EXCERPT FROM NFPA "LABORATORIES" FIRE RECORD:
"This type of explosion will become ancient history when explosion proof refrigerators are used exclusively by industry." FR-58-3

THE ANSWER...

KELMORE EXPLOSION PROOF REFRIGERATORS... used right now by General Motors and General Electric, two of the world's largest manufacturers of kitchen type units. KELMORE can't ignite, won't explode. They're UL approved for hazardous locations Class C&D... will give you years of trouble free service. Economical, too. Send for complete catalogue. It's yours free.

MANUFACTURED BY

KELMORE, INC.

599 SPRINGFIELD AVENUE
NEWARK 3, NEW JERSEY

Now

Armstrong announces

the first and only

fire-retardant acoustical

lay-in ceiling

system

New U. L.-approved grid ceiling system gives three-hour protection for structural steel

THE new Armstrong Acoustical Fire Guard lay-in ceiling combines the advantages of the exposed grid suspension system—economy, fast installation, accessibility—with those of a time-design-rated acoustical ceiling.

The new system protects the structural components of a building by resisting the dangerous transmission of heat from one area to another. This lay-in unit—because of its composition—can withstand exposure to flames and 2,000-degree heat.

Underwriters' Laboratories, Inc., has given the new system a beam protection rating of three hours. Assemblies using bar joist and slab, as well as beam and steel floor construction, earned two-hour time-design ratings. In areas which require more protection, Acoustical Fire Guard *tile* can be used. Acoustical Fire Guard tile has U. L. ratings of up to *four* hours.

Armstrong Acoustical Fire Guard lay-in units are available in the popular Classic design. A Fissured pattern will soon be on the market. There are two nominal sizes: 24″ x 24″ x ⅝″ and 24″ x 48″ x ⅝″.

For more information about either Acoustical Fire Guard tile or lay-in units, call your Armstrong acoustical contractor or your nearest Armstrong District Office. Or write to Armstrong Cork Company, 4201 Woodbridge Street, Lancaster, Pennsylvania.

Armstrong ACOUSTICAL CEILINGS

First in Fire-Retardant Acoustical Ceilings

HIGH VALUES · MAXIMUM PROTECTION

"AUTOMATIC" SPRINKLER FOAM-WATER DELUGE SYSTEM

guards $26,000,000 hangars—helps maintain TCA record of customer service!

Trans-Canada Air Lines at its giant new Montreal Overhaul and Maintenance Base chose the "Automatic" Sprinkler Foam-Water Deluge System as maximum protection for the heart of its service facilities, two huge hangars—6 acres of floor space. Every square foot, every jig, fixture, part, every aircraft is guarded by over 3000 foam-water sprinklers ready to discharge fire-smothering foam.

Trans-Canada, in common with many other large transportation and industrial concerns, realizes the importance of protecting high values in equipment and customer relations with fast, reliable, positive protection.

INSTALLATION TEST shows fire-smothering blanket from Foam-Water System (Rate-of-Rise operated) installed by "Automatic" Sprinkler Co. of Canada, Ltd.

BEFORE YOU DECIDE

on protection for *your* high values against flammable liquid fires, see "Automatic" Sprinkler's new motion picture, "Automatic" Foam-Water Sprinkler Systems. Write today.

"Automatic" Sprinkler CORPORATION OF AMERICA

MANUFACTURERS AND INSTALLERS OF APPROVED FIRE PROTECTION EQUIPMENT

GENERAL OFFICES
YOUNGSTOWN 1, OHIO

ION

hering
of-Rise
rinkler

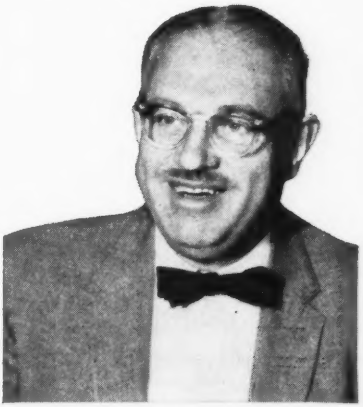
ICA
ENT
ICES
OHIO

At Gillette...

It's GAMEWELL Fire Protection

"During periodic fire drills at Gillette, a Gamewell fire alarm system has proved itself much faster, much more trouble-free than the one it replaced. We appreciate the excellent protective value of the Gamewell system and your aid in engineering it to cover all buildings in our plant area."

A Gamewell System can be engineered to safeguard *your* business from fire losses . . . warn all personnel . . . signal local fire department. If required, will include fire detection units that activate entire system automatically. For details, write THE GAMEWELL COMPANY, 1335 Chestnut St., Newton Upper Falls 64, Massachusetts. *A subsidiary of E. W. Bliss Company.*



HOWARD SPAULDING
Chief Electrical Engineer
Gillette Safety Razor Company
Boston, Massachusetts

BLISS Gamewell®

FIRST...WHEN SECONDS COUNT

GRINNELL WATER SPRAY SYSTEM under test at the Marietta, Ohio plant of the Bakelite Union Carbide Plastic Company, a division of the Union Carbide Corporation. Water — when it is applied in time and distributed over the surfaces efficiently by a properly engineered system — is most effective in limiting tank fires and controlling their spread.

Keep tank fires from getting out of control with Grinnell Water Spray

Proper safeguards are uppermost in importance in protecting tanks which contain flammable gases and liquids in the event of fire. For example, tanks must be guarded against extreme heat exposure. Leaking gas, if it should develop, must be diluted to the point where it will not burn. And fire, if it should occur, must be localized and controlled or extinguished.

With a Grinnell Water Spray System, you get such protection.

Before heat raises tank temperatures dangerously, an enveloping spray of water provides instant cooling, reducing internal pressure which helps prevent rupture. In addition, air turbulence is created (even in still air) which, in conjunction with the water vapor from the spray, helps dilute the flammable vapors to control or extinguish the fire. Flammable products which cannot be safely extinguished can be safely burned off under the protecting water spray.

FREE REFERENCE MANUAL. For a comprehensive picture of all the most advanced methods of special hazard fire protection, request your free copy of "Special Hazard Fire Protection by Grinnell." Write Grinnell Company, Providence 1, R. I. Branches in principal cities.

GRINNELL

FIRE PROTECTION SYSTEMS SINCE 1870

e Plastic
tributed
res and

n the
apors
flam-
afely
d off

hen-
nced
tion,
zard
rite
R. I.

70